Health and Diet in Upper Nubia through Climate and Political Change - A bioarchaeological investigation of health and living conditions at ancient Amara West between 1300 and 800BC

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A bioarchaeological investigation of health and living conditions at ancient Amara West between 1300 and 800BC

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Volume I – Text

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Abstract

Health and Diet in Upper Nubia through Climate and Political Change

Michaela Binder

This thesis aims to investigate the impact of environmental and socio-political changes on health and living conditions in the ancient settlement of Amara West, Sudan (1300–800BC) through a diachronic comparison of selected indicators of disease and physiological stress on skeletal human remains. The town served as the administrative capital of the province Upper Nubia during the later phase of New Kingdom Egyptian occupation of Nubia (1300–1070BC). Despite the end of Egyptian control, settlement in the area continued until the 8th century. Palaeoenvironmental evidence from the region indicates that the period of occupation of the site further coincided with general climatic deterioration through increased aridification during the late 2nd and early 1st millennium BC.

Whether these climatic and political changes would have had an affect on health and living conditions at Amara West is explored through comparing multiple markers of physiological stress and disease (stature, orbital changes, dental disease, evidence of non-specific infection, respiratory diseases, endocranial changes, trauma, osteoarthritis) recorded through macroscopic examination of skeletal human remains from the New Kingdom (1300–1070BC, N=36) and post-New Kingdom period (1070–800BC, N=144). Analysis of stable oxygen and carbon isotopes was also included in the study. Applying a bio-cultural approach, interpretation of the results is complemented by contextual data drawn from ongoing research in the cemeteries, settlement and surrounding habitat.

Despite limitations due to the bias in sample size, the systematic statistical comparison revealed several tentative trends such as decreasing stature, increased levels of osteoarthritis, dental pathologies, pulmonary diseases, post-cranial fractures and high levels of sub-adult mortality. Changes in stable oxygen isotope composition indicate increasingly arid conditions during the post-New Kingdom period. In light of palaeoenvironmental and isotopic data, the palaeopathological results may therefore reflect the health consequences of severe environmental changes as well as changes in settlement structure.

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In order to allow for better representation and higher quality of reproduction, images and drawings of tombs, assemblages of grave goods and selected pathological changes are presented in Appendix III. Selected plans and images to illustrate key points in the text are presented as figures within the main body of the thesis. All images are copyrighted Courtesy Trustees of the British Museum unless otherwise indicated.

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Statement of copyright

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For my parents

Chapter 1. Introduction

1.1. Amara West

Human health is determined by a complex set of interactions between environmental, socio-cultural, physiological and psychological parameters. Alterations of one or more of these parameters can therefore have a significant impact on the health status of an individual or a group. This thesis aims to investigate health and living conditions in a population exposed to significant environmental and political changes. Between 1500 and 1070BC, much of Nubia between the 1st Cataract in southern Egypt and the 3rd Cataract in northern Sudan, was under the control of the Egyptian Pharaonic empire. Amara West served as the administrative capital of the Egyptian province Kush (Upper Nubia) between 1300 and 1070BC. Historic and archaeological evidence suggests that the walled settlement would have housed colonial officials, military personnel, alongside a local community involved in agriculture, mining and industrial activities such as metal work or manufacture of pottery. Associated with the settlement, to the north, are two large cemetery areas overlooking the site from across a dried-up river channel. Material culture and architectural layout across the site draw a picture of a complex hybrid culture integrating both Egyptian and indigenous Nubian elements.

Even though occupation layers have not been identified yet, evidence from the cemeteries suggest that people lived at or near Amara West until the 8th century despite the effective end of Pharaonic control around 1070BC. Palaeoenvironmental research indicates significant environmental changes occurring over the time period of use of the settlement, ultimately leading to the abandonment of the site. The two cemeteries and the people buried within them form the basis of the research presented in this thesis. Based on the historic, archaeological and palaeoenvironmental data (see Chapter 2 and Chapter 3.), two main hypotheses can be formulated; these will briefly be outlined in the following section.

1.2. Hypotheses

1.2.1. Hypothesis 1: The end of Egyptian colonial control led to a disruption of the infrastructure of the settlement which had a negative influence on people living at Amara West.

The relationship between political and/or cultural systems and health is very complex and is made up of a wide range of different areas (Larsen, 2001). Changes in political rule may significantly impact on population health, both positively as well as as negatively, with numerous examples in both modern and historic contexts. A number of bioarchaeological studies have investigated the relationship between colonial encounters and the health of "conquered" populations. The most extensively studied areas are the impact of European conquest on native populations in the Americas (Larsen & Milner, 1994, Larsen, 2001) and pre-contact imperialism in the Andean Region (Tung, 2003, Andrushko, 2007).

Egyptian colonial settlements played a role in the maintenance of control over occupied Nubia. They served as trading posts and centres of collection for tributes from the occupied territories which may have contributed to the significant wealth of these settlements (Kemp, 1978). Administration was organised along Egyptian lines and placed under the rule of a high offical. It has traditionally been assumed that the breakdown of the colonial administration at the end of the New Kingdom period and any subsequent disruption to onward trade with regions further to the south, may have caused serious disruption of the socioeconomic structure of these communities. However, recent fieldwork results in the Nubian settlements are now leading to a more nuanced view, suggesting that state involvment in these colonies was already dwindling throughout the later phase of the New Kingom period (Spencer, 2014c). These socio-political changes may have impacted on the health and living conditions of the people living at Amara West.

1.2.1. Hypothesis 2: Deteriorating environmental conditions led to increased environmental stress, poorer living conditions, changes in dietary resources and a decline in health in the people inhabiting Amara West, which ultimately led to the abandonment of the site.

The natural and built environment represents one of the three main factors governing the human disease spectrum (Meade & Earickson, 2000: 25). Consequently any changes in the living environment, natural or built, can potentially have significant impacts on health. Climate change has been recognised as one of the major environmental problems that our world is facing today. Its negative impact on human health is now a well established fact (WHO, 2009). The pathways through which changes in climate influence human health are complex, and find a large number of manifestations including the presence and levels of infectious and nutritional diseases or physical activity (e.g. Confalonieri *et al.*, 2007, Portier *et al.*, 2010). Amongst the most detrimental facets of environmental change ranks land degradation caused by aridification and desertification (WHO, 2013c). Despite its modern relevance, climate change has rarely been addressed from a bioarchaeological point of view (Roberts, 2010). Notable exceptions are the works of Lukacs & Walimbe (1998), Schug (2011) and more recently Harrod & Martin (2014).

Geomorphological and palaeoenvironmental research at Amara West has recently produced several lines of evidence indicating that the area underwent significant environmental deterioration throughout the time period of use of the settlement and cemeteries (Spencer *et al.*, 2012, Dalton, Forthcoming). Amongst the most severe manifestations is the cessation of the palaeochannel on the northern side of the settlement, which would have significantly decreased agricultural productivity and increased the amount of air pollution through aeolian dust. These environmental alterations would have had a substantial impact on the health of the people living at Amara West.

1.3. Research questions

Based upon the above formulated hypotheses, this research project aims to address the following key questions:

(1) Are there any differences in health status and diet between the people buried in the New Kingdom cemetery living at Amara West during the time of Egyptian rule, and those buried in the cemeteries used in the following three centuries?

(2) If so, can any observed differences in health status and diet be linked to climatic and political changes, or even different geographical origins or ethnic ties, as indicated by stable strontium and oxygen isotope analysis and the funerary rituals employed by the people living at Amara West?

These research questions are addressed through palaeopathological analysis of the human remains from the two temporally distinctive cemeteries located next to the town of Amara West excavated between 2009 and 2013 (Binder *et al.*, 2010, Binder, 2011, 2014). In comparing the results from the New Kingdom and the post New Kingdom cemeteries, it is anticipated that any changes occurring during the time period in question can be detected through analysis of the buried human skeletal remains. Health status of individuals are evaluated based on selected markers of physiological stress and disease. Because human health represents the outcome of complex interactions of environmental, cultural and biological factors, an understanding of these determinants is crucial for inferences about human health in the past. Consequently, the data gained from the palaeopathological analysis are complemented by a large body of palaeoenvironmental and archaeological evidence from the ongoing excavation and research within the related settlement site and habitat.

1.4. Structure of the thesis

This thesis is divided into ten chapters. Chapter 1 gives an introduction to the aims, hypothesis and research questions addressed in the thesis. In order to set the historical and archaeological frame for the bioarchaeological analysis, Chapter 2 provides an overview of the historic developments in Upper Nubia before and during the time of occupation of Amara West, while in Chapter 3 the settlement and cemeteries are introduced in more detail. The theoretical and clinical foundations of the bioarchaeological study of health and disease as well as the indicators used in this study are introduced in Chapter 4. In Chapter 5, the background and principles of stable isotope analysis are briefly discussed. Chapter 6 provides a review of bioarchaeological research in Nubia. The assemblage of skeletal human remains forming the basis of this thesis is introduced in Chapter 7 with regards to taphonomy, preservation and sample size, as well as the methods and recording procedures applied to analyse the human remains. The results of the bioarchaeological and biomolecular analysis are presented in Chapter 8 and will be discussed within their archaeological, cultural, socio-economic and environmental context in Chapter 9. In the concluding Chapter 10, the results are briefly summarized, the original hypotheses are revisited and limitations, outlook and significance of the data are briefly discussed.

Chapter 2. Historic background

The cultural, political and historical background of the people living at Amara West between 1300 and 800BC is crucial in order to understand the social and cultural dynamics and to address the research questions outlined in Chapter 1. However, it can only be understood within the broader regional context. This chapter introduced the historic development leading up to and during the time period of settlement at Amara West. A summary of the chronological developments in Nubia and neighbouring Egypt is provided in Table 2.1.

2.1. Nubia – Names, people and places

The word "Nubia" has been used in many different ways and definitions of its boundaries have changed considerably throughout history (Edwards, 2004: 1). Today, the region referred to as Nubia stretches from the 1st Cataract at Aswan/Elephantine in Egypt to the 6th Cataract near the confluence of the Blue and the White Nile in Northern Sudan (O'Connor, 1993, Smith, 2003: 4; see Figure 2.1). It is confined to the riverine landscape along the Nile Valley even though the exact limits of the fertile land were subject to considerable changes over the past five millennia. In contrast, the term "Nubia" is also used to refer to the homelands of ethnic Nubians (Morkot, 2000: 3). In this work, "Nubia" is solely used as a geographical term in order to refer to the above outlined region of Southern Egypt and Northern Sudan regardless of any ethnic connotation. In describing its inhabitants, "Nubian" is used to refer to the indigenous populations living in the geographic region of Nubia as outlined above, not to an ethnicity, polity or language (O'Connor, 1993: xii).

2.2. The Bronze Age cultures of Nubia (2500–1500BC)

When the Egyptian army invaded Nubia around 1500 BC, they met upon a fully developed indigenous state dominating large parts of the Middle Nile Valley. This first Kingdom of Kush represented the first substantial sub-Saharan kingdom, dominating large parts of the Middle Nile Valley from 2000 BC onwards (Edwards, 2004: 75). Designated through a very distinctive material culture, it is more widely known named after the administrative and religious centre of the Kushite Kingdom near the modern town of Kerma (Bonnet, 2004b). At the same time, cultural developments taking place in Lower Nubia were significantly different and the area north of the 2nd Cataract came under increasing Egyptian influence from around 2000BC onwards.

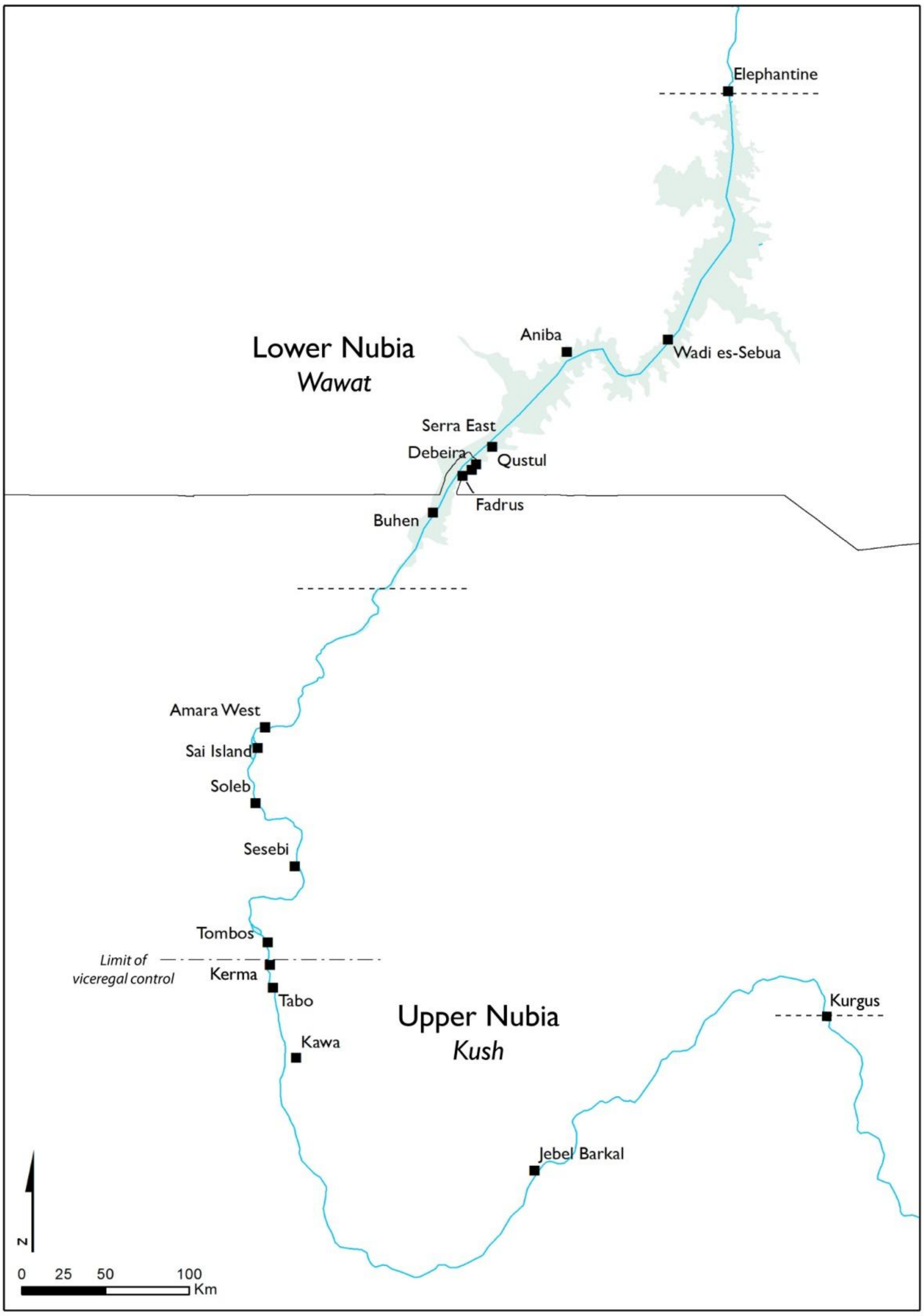

Figure 2.1 Map of Nubia showing the location of major New Kingdom sites mentioned in the text (created by M. Binder)

	Upper Nubia	Lower Nubia	Egypt
2500	**Kingdom of Kush**	**C-Group**	
	Kerma ancien 2500–2050BC	C-Group Ia-Ib 2500–2050BC	Old Kingdom 2682–2181BC First Intermediate Period 2181–2055BC
2000	*Kerma moyen* 2050–1750BC	C-Group Ib-IIa 2050–1750BC	Middle Kingdom Period 2055–1650BC
	Kerma classique 1750–1500 BC	C Group IIb–III 1750–1500BC	Second Intermediate Period 1650–1550BC
1500	Late Kerma 1500–? BC Egyptian occupation 1500–1069BC	Egyptian occupation 1500–1070BC	New Kingdom 1550–1069BC
1000	?	?	Third Intermediate Period 1069–656BC
	Kingdom of Kush		
500	Napatan Period 8th–4th century BC		25th Dynasty – Nubian rule over Egypt 716–656BC
	Meroitic Period 4th– 4th century AD		Late Period 664–332BC
0			Ptolemaic Period 332–30BC
500	Post–Meroitic Period 350–540AD		Late Antique Period 30–641AD
1000	Medieval Period 550–1450AD		Medieval Period 641–1517AD
1500	Islamic Period 1450AD–		Modern Egypt 1517AD–

Table 2.1 Chronology of Nubian and Egyptian history (cf. Gratien, 1978, Edwards, 2004: 81, Welsby & Anderson, 2004)

2.2.1. Upper Nubia: The Kingdom of Kerma

The Kerma Kingdom is generally divided into three periods, *Kerma ancien, moyen* and *classique*. The earliest stage (2500–2000BC) is, to a large degree, only known through excavation and analysis of cemeteries (Gratien, 1978). Major differences in the richness of grave goods in Kerma cemeteries was interpreted as an indication of increasing social stratification and perhaps already suggesting the development of a political organization from a simple chiefdom to a more complex state (Bonnet, 2004b: 72). Little is known about settlement structures of the developing Kerma state due to the fact that these consisted of simple huts which leave only faint, ambiguous archaeological traces, but also due to lack of survey in some areas (Edwards, 2004: 82). It has been suggested, that the ephemeral nature of these *Kerma ancien* settlements attests to a nomadic or semi-nomadic lifestyle based on cattle herding (Gratien, 1978).

The *Kerma moyen* period, at the beginning of the first half of the 2nd millennium BC and contemporary with the Egyptian Middle Kingdom period (2055–1650BC), saw considerable cultural developments in Upper Nubia, eventually leading to the rise of the powerful Kushite Kingdom (Edwards, 2004: 90–91). The introduction of mudbrick as building material, likely brought from Egypt, led to significant changes in settlement structures. Increased urbanism at Kerma, the town that was to become the religious and administrative capital of the kingdom, is indicated by the construction of substantial fortifications, advanced domestic architecture, an increased specialization of the buildings as well as the establishment of a major religious quarter. The rising wealth and social hierarchy within the Kerma state is also indicated by the increasingly impressive burial mounds and the development of elaborate funerary practices (Bonnet, 1999). *Kerma moyen* burial mounds at the necropolis of Kerma attributed to the Kushite rulers, reached sizes of up to 40m in diameter, some of them furnished with up to 4000 sacrificed animals (Bonnet, 2004b).

The growing power and wealth of the Kushite kingdom has been attributed to a number of factors. Survey in the area around Kerma has revealed that by the time the kingdom was at its prime, the Nile was flowing in at least three parallel channels, creating a large floodplain which would have yielded enormous agricultural potential and could have sustained a large number of people (Welsby, 2001). Furthermore, owing to its location, Kerma controlled the trade with Egypt in luxury goods such as gold, ivory, ebony and animal skins coming from the regions to the south and south-west, as well as from the Eastern Desert and the Red Sea Coast (Bonnet, 2004b).

The precise nature of these early relationships as well as the importance of Egyptian influence on the development of the Kushite kingdom is still difficult to determine (Edwards, 2004: 90). Egyptian textual sources attest to diplomatic relationships and trade between the Middle Kingdom state and Kush. Major Egyptian influences can be seen in technical advancements and crafts such as the introduction of mudbrick or techniques such as faience manufacture, suggesting the presence of Egyptian artisans at the courts of the Kushite rulers (Morkot, 2000: 62).

Little is known about the internal structure of the Kushite Kingdom during this period. Egyptian texts refer to a number of different political entities sharing power over the region (O'Connor, 1991, Edwards, 2004: 79). From the time of the Egyptian Middle Kingdom onwards, the most important of these states was Kush centring on Kerma, with further centres at Shaat, identified as Sai Island, and Wawat in Lower Nubia (O'Connor, 1991). During the *Kerma moyen* period, those polities despite sharing the same cultural tradition seem to have been largely independent of each other.

While Egypt fell into political fragmentation after the invasion of the Hyksos rulers in northern Egypt and the division of the country into the Theban state in Upper Egypt and Hyksos state in Lower Egypt during the Second Intermediate Period (c. 1750–1500BC), Upper Nubia saw a period of prosperity with the greatest developments and expansion both at Kerma and in the entire Kushite kingdom (Edwards, 2004: 94–95). During the *Kerma classique* period, the Kerman rulers expanded their control over all of Lower Nubia, reaching as far north as Aswan, which is indicated by the occurrence of *Kerma classique* settlements and cemeteries throughout the area. In addition, formerly independent polities in the north such as Shaat were incorporated into the Kerman state and became vassals (O'Connor, 1991).

At Kerma itself, the extent of the city and the wealth of the ruling Kings reached their climax during the *Kerma classique* period. Architectural changes to the fortifications and temples gave the city an increasingly monumental appearance. The massive royal tombs at Kerma best document the grandeur and power of the Kerman rulers, some even provisioned with large numbers of human sacrifices (Bonnet, 2004b). Several elements within the burials attest to the continued importance of Egyptian cultural influence acquired during the Middle Kingdom (Kemp, 1983: 166). Trade continued to be the major source of wealth for the Kerman rulers, and widespread trading relationships with the Hyksos rulers of the Second Intermediate Period residing in the Nile delta are documented by the abundance of mud sealings bearing the names of Hyksos rulers found at Kerma (Kemp, 1983: 167). The relationship with the Theban state in Upper Egypt changed into one of open hostility. Findings of Egyptian statues and stone vessels in Kerman temples and burials, which originated from temples in Upper Egypt, as well as inscriptions attest to frequently occurring raids of the Kushites into the territories beyond their northern borders (Török, 2009: 109–110).

2.2.2. Lower Nubia: The C-Group culture

Lower Nubia was homeland to the C-Group people who can be first traced in Lower Nubia around 2300BC, settling in the area between Kubanieh, north of the 1st

Cataract, and the 2nd Cataract in the south (Bietak, 1968: 16). The *Batn-el-Hajar* (Belly of Rocks), a rocky stretch of the Nile south of the 2nd Cataract, acted as a natural boundary and no evidence of C-Group settlement south of this region has ever been recovered. The origins of the C-Group are now commonly accepted to lie in Upper Nubia and share a common origin with the *Kerma ancien* people in Upper Nubia (Edwards, 2004: 77). Nevertheless, the groups settling in Lower Nubia north of the 2nd Cataract were soon to develop a very distinctive material culture (Edwards, 2004: 90)

The archaeological record for the C-Group in Lower Nubia is relatively good, owing to extensive excavations during the First Archaeological Survey of Nubia in the early 20th century (see Section 6.1.1) and the salvage campaigns of the 1960s (see Section 6.1.2), although again it mainly comes from cemeteries. Very few C-Group settlements have been identified (Edwards, 2004: 88), and thus settlement patterns will remain unknown as the area they once occupied is now fully flooded. It was suggested that this scarcity in settlement sites is due to the fact that C-Group people were living in small farmsteads rather than in larger settlements (Bietak, 1968: 87), but it might also be explained by the fact that the ancient settlement sites coincided topographically with modern settlements (Säve-Söderbergh, 1989: 9).

Consequently, little is known about subsistence patterns of the C-Group people. Based on the abundant depiction of cattle and herdsman on vessels, rock drawings and stelae, the C-Group people were originally regarded as cattle pastoralists by early researchers (Adams, 1977: 152–153). However, though the importance of cattle cannot be doubted it was perhaps more an ideological one, as the archaeological evidence rather points to a more generalized subsistence based on agriculture (Trigger, 1976: 52, Adams, 1977: 152–154). The size of the settlements and cemeteries, as well as the abundance of pottery, rather argue for a more sedentary and urbanized lifestyle. Furthermore, the climatic conditions in Lower Nubia would have already restricted pastural land to the banks of the Nile, preventing large scale cattle herding (Adams, 1977: 154).

With regard to social structure of the C-Group people, the lack of excavated settlement sites leaves any conclusions rather elusive. Based on the absence of any clear distinction between poor and rich graves in C-Group cemeteries, Trigger (1976: 79) concluded, that the C-Group was an *egalitarian, tribal society in which status differences were not expressed in terms of a distinct lifestyle*. Whether slight differences in size of the graves over time are indicative of a growing social stratification, inferring an organisation consisting of complex chiefdoms, as has been suggested by O'Connor (1993: 159), remains disputed (Smith, 2003: 78). C-Group rulers (*heka*/hw3) are also accounted for in Egyptian textual sources, arguing for a more developed social hierarchy (Säve-Söderbergh, 1989: 12).

Contemporary to the formation and rise of the Kerman kingdom, Lower Nubia was invaded by Egyptian forces and integrated into the Egyptian empire. Already at the beginning of the 2nd millennium BC, under the reign of the first Pharaoh of the 12th Dynasty Amenemhat I (1985–1956BC), Egyptian troops started pushing south, conquering the territory of *Wawat* in Lower Nubia, up to the 2nd Cataract. Under his successors a string of forts were built along the 2nd Cataract area as far south as Semna at the upstream end of the *Batn-el-Hajar*, manned with Egyptian military personnel. The purpose of these large, impressive fortresses is disputed. While Adams (1977: 185–186) doubted a military character for the fortresses due to an apparent lack of threat from Nubian populations, others have contradicted this view, stressing the growing strength of the Kushite Kingdom to the south (Trigger, 1976: 74–75, Smith, 2003: 76) as well as possible threats posed by groups from the Eastern desert (Morkot, 2000: 57–58). Perhaps more as a preventive measure, the forts were built not only to protect the southern frontier but also to secure the trade routes along the Nile. In addition, the forts also served an economic function in southern trade and to facilitate and control the exploitation of the natural resources, most importantly the goldmines of Lower Nubia (Trigger, 1976: 67–68, Kemp, 1997). While at the beginning of Middle Kingdom control over Lower Nubia, the forts were manned with rotating garrisons, this changed to permanent garrisons during the 13th Dynasty (1773–1650BC). Egyptians, including officials and their families, settled in the fortresses and garrison commands often became hereditary (Edwards, 2004: 93).

Interaction between the Egyptians living inside the fortresses and the local C-Group population settling in the surrounding area are assumed to have remained minimal. C-Group sites contemporary with the main phases of Middle Kingdom occupation of Lower Nubia still show a strong difference in material culture and only very little Egyptian influence (Edwards, 2004: 94). While it was suggested that this might have represented some form of resistance, Smith (2003: 77) suggested that the lack of hierarchical organisation of the C-Group people would have made them unsuitable collaborators for the Egyptian administration.

Egyptian control over Lower Nubia was finally lost at the end of the 13th Dynasty and the fortresses were occupied by the invading Kushites. The relationship between the rise of the Kushite state and the breakdown of the Egyptian Empire is still subject to debate. Based on the traditional view that Nubia was less politically advanced than Egypt, some researchers (1976: 150, Adams, 1977, Edwards, 2004: 95) suggested that throughout history Nubian states could only rise during phases of Egyptian internal weakness, which would have prevented Egypt from interfering. This view was contested by Morkot (2000: 62–63) and O'Connor (1991: 145), claiming that this was an underestimation of power of the Kushite state and that in fact Nubia's strength was a contributing factor to Egypt's weakness. With a growing body of archaeological research in Upper Nubia it becomes increasingly evident that by the 13th Dynasty Kush had already developed into a wealthy, powerful state. In addition, increased Kushite military activity can be traced in Lower Nubia and there is evidence for hostile actions against the Egyptian forts in the 2nd Cataract area (Morkot, 2000: 64). Thus, it was suggested that the Kushite expansion into Lower Nubia was brought about by deliberate aggression rather than as a more passive reaction to the weakening Egyptian control (O'Connor, 1993, Morkot, 2000).

C-Group people continued to thrive under Kushite rule and their material culture increasingly shows the influence of Kerman cultural elements (Bietak, 1968). In addition, people of a different cultural affiliation, termed the Pan Grave culture after the distinctive shape of their graves, started to settle in smaller groups in Lower Nubia. Even though their origins were suspected to lie somewhere in the Eastern desert, many aspects of the group, such as reasons for their appearance or their relationships with local C-Group populations remain unknown (Edwards, 2004: 100). The 2nd Cataract fortresses continued to be occupied or were re-occupied after a short period of time by invading Kushites, which is indicated by the fact that the material evidence recovered from the fortresses changes to being exclusively Kerman in the period after the end of Egyptian rule (Edwards, 2004: 94). The Egyptian officials who had settled in the fortresses during the Middle Kingdom remained in Nubia. They put themselves under the command of the Kushite rulers and were allowed to continue to pursue their own cultural traditions (Morkot, 2000: 64). Thus, settlements in Lower Nubia during the *Kerma classique*/ Second Intermediate Period may have consisted of a mixed population combining elements of Egyptian, Kerman, C-Group and Pan Grave cultures (Török, 2009: 116)

2.3. The New Kingdom occupation of Nubia

2.3.1. The conquest of Nubia

After the wars of the late Second Intermediate Period, the Hyksos were finally defeated under the reign of the Ahmose (1550–1525BC), the first ruler of the 18th Dynasty, and Egypt was re-united, marking the onset of the New Kingdom period. Subsequently, Ahmose led the first military campaigns against Nubia and rapidly occupied Lower Nubia, perhaps already as far south as the 3rd Cataract. Under his successor, Amenhotep I (1525–1504), the army advanced further south attacking the Kerman state. During the following campaigns led by Thutmose I (1504–1492BC) around 1500BC, the capital of the Kerman Kingdom was sacked and Thutmose I's army advanced as far south as the 4th Cataract where the southern boundary of the Egyptian Empire was marked with a boundary stela at Kurgus north of the 5th Cataract (Edwards, 2004: 101–102, Török, 2009: 157–160).

While occupation in Lower Nubia had already been consolidated under Thutmose I, defeat of the Kerman state and the conquest of Upper Nubia was still superficial at best. This is indicated by extensive restoration work in Kerma itself and textual evidence for continued attacks against the Egyptian army by Nubian rulers. Full domination of the Nubian territories including the 4th Cataract as its southern most extension, was only to be established under the later years of the reign of Thutmose III (1457–1425BC), who marked his territory with a second boundary inscription at Kurgus (Davies, 1998, Török, 2009: 161–162). With the final destruction of Kerma town by Thutmose III's armies, the power of the Kerman state was broken for good (Török, 2009: 166). However, the chronology of the Egyptian conquest and transition from Classic Kerma to the New Kingdom are still under debate. After Kerma was destroyed, activity was moved to a new Egyptian settlement at nearby Dukki Gel (Bonnet, 2004a). Ongoing excavations at both sites continue to bring to light new evidence which is crucial in understanding the chronology of the Egyptian conquest of Nubia (Bonnet & Valbelle, 2010).

Following the conquest of Nubia, the administration of the occupied territories was completely reorganized along Egyptian lines. The authority was placed under the reign of a viceroy, who was drawn from the Egyptian elite and resided at Thebes (Morkot, 2000: 75). The viceroy was in charge of the civil government of Nubia, his responsibilities comprising the collection and delivery of tributes and taxes as well as the control of the gold mining areas (Török, 2009: 179). From at least the reign of Thutmose III onwards, Nubia was divided into two provinces: *Wawat*, the area of Lower Nubia between the 1st and 2nd Cataracts and *Kush*, the area of Upper Nubia between the 2nd Cataract and the 4th Cataracts. Both provinces were placed under the rule of a deputy who was appointed by the viceroy from the ranks of the Nubian administration and seems to have been a native Nubian. While the deputies of Wawat resided at Aniba throughout the New Kingdom, the seat of the deputy of Kush was first at Soleb during the 18th Dynasty and then moved to Amara West under the rule of Seti I (1294-1297BC) during the 19th Dynasty (Török, 2009: 180).

While it was initially assumed that Egyptian colonial control was administered by Egyptians (Adams, 1977: 166), more recent research favours a model in which authority may have been predominantly left in the hands of "Egyptianized" Nubians who pledged allegiance to the pharaoh (Morkot, 2000: 81–90, Smith, 2003: 84). Local elites were allowed to hold high positions within the Viceregal administrative system and thus to retain a certain degree of power, which was perhaps one of the crucial factors in maintaining control over Nubia (Säve-Söderbergh, 1991). By educating Nubian princes at the Egyptian court and through diplomatic marriages of Nubian princesses, the local elites were co-opted and drawn towards Egyptian culture. They adopted Egyptian names and within their tombs they displayed themselves in a manner similar to high officials in Egypt proper. These practices also played a major role in the acculturation of the Nubian population.

Control over Nubia was initially established and maintained by the construction of colonial settlements and military camps shortly after the conquest of Nubia (Török, 2009: 182). While during the early stages of re-conquest, building activities mainly concentrated on the re-occupation of the Lower Nubian Middle Kingdom fortresses, such as at Buhen, Mirgissa, Askut or Aniba, from the reign of Thutmose III onwards new Egyptian style towns were erected throughout Nubia to become the centres of Egyptian administration. During the 18th Dynasty (1550–1295BC), major settlements were erected at Sai, Soleb, Sesebi, Tombos, and Dukki Gel close to Kerma city, as well as at Gebel Barkal (Török, 2009: 182–191). Construction activities in Nubia continued during the 19th Dynasty (1295–1186BC) with building of the temple towns at Serra West and Amara West and reached its height during the reign of Ramses II (c. 1295–1186BC) (Török, 2009: 192–193). The nature of these settlements still remains poorly understood, even though ongoing excavations at Sesebi, Sai or Tombos are likely to shed light on this matter in future.

Despite Egyptian presence being indicated by inscriptions as far south as Kurgus at the 5th Cataract, the extent of this presence and control over Nubia remains far from clear (Morkot, 1991). While in Wawat, the situation is better known due to the large number of excavated sites, indicating considerable Egyptian influence, very little is yet known about the areas to the south, particularly those south of the 3rd Cataract within the Kerman heartlands. However this picture is now slowly starting to change with ongoing field work and survey during recent years (e.g. Welsby, 2001, Smith, 2007, Bonnet & Valbelle, 2010, Edwards, 2012). So far, settlement sites south of the 3rd Cataract have been identified at Nauri, Tombos, Hillat el-Arab, Kawa, Doukki Gel and at Gebel Barkal. Despite extensive surveying in the Mahas region between Soleb and Tombos-Hannek (Edwards & Ali Osman, 1992, 1993, Edwards, 2012) as well as in the Dongola reach (Welsby, 2001) only a small number of additional sites dating to the New Kingdom period with Egyptian cultural material could be detected. However, ongoing fieldwork in the region is now bringing up new evidence and may shed further light on these questions in coming years (Welsby, Thomas, pers. comm. 2014). Where sites continue to be occupied during the New Kingdom, they seem to continue Kerman cultural traditions. According to Smith, the small number of colonial towns rules out a high degree of control but rather argues for a model of hegemony where control was mainly left in the hands of Nubian princes loyal to the pharaoh (Morkot, 2000: 76, Smith, 2003: 94). Nevertheless, the presence of pharaonic settlements at Dukki Gel, Tombos or Gebel Barkal, attest to a considerable Egyptian influence even at the far end of the empire.

2.3.2. Egyptian motives and strategies of colonial control

The centuries of Egyptian colonial control over Nubia are marked by significant socio-cultural changes within the indigenous Nubian communities. Despite a long-standing history of archaeological research in Egypt and Nubia, these processes are still far from being understood. Understanding the underlying motives and strategies of Egyptian control over Nubia during New Kingdom occupation remains important in order to contextualise any attempts to study life in Egyptian settlements in Nubia. This subject has been matter of considerable scholarly debate over the past decades and is still far from being resolved (e.g. Kemp, 1978, Kemp, 1997, Smith, 2003: 58).

Interactions between Egypt and Nubia during the time period of New Kingdom occupation were often characterised as a core-driven centre-periphery model. According to this model, widely used in research on ancient colonial systems, colonialism is characterised as the dominance of an economically, socially and politically highly developed core over a less developed, dependent periphery (Stein, 1998). A similar model has also been applied to describe Egyptian-Nubian relationships during the New Kingdom. Derived from a rich corpus of Egyptian textual sources, motivations for Egyptian conquest of neighbouring territories were sought in Egyptian state ideology, demanding expansion of the Egyptian state as a duty to the gods (Kemp, 1978, 1997).

The core-periphery model has largely been criticised for simplicity and failing to acknowledge native agency (e.g. Stein, 1998, Smith, 2003: 60, Stein, 2005). Alternatively, Stein, in his appraisal of imperialism in ancient Mesopotamia in the 3rd millennium BC proposed a distance-parity model in which the core's ability to exercise hegemonic power decays with distance, leading to increasing parity in economic and political relationships with increasing distance from the core (Stein, 1998). A similar model explaining Egyptian-Nubian relationships was proposed by Smith (Smith, 1995, 1998, 2003) who also placed more emphasis on economic motives behind Egypt's expansion rather than ideological factors as proposed by Kemp (Kemp, 1978). Egypt's main interest in Nubia always originated in access to valuable resources much sought after by the Egyptian state, first and foremost gold but also other luxury goods such as ebony, ivory, incense or exotic animals (Zibelius-Chen, 1988). The importance of gold exploited from mines in Lower Nubia and the Eastern desert is richly documented by a large corpus of Egyptian textual sources. Its most important function was to enable the New Kingdom Egyptian state to maintain her political dominance in western Asia (Morkot, 2000: 76–78). Despite being less rich in gold mines, control over Upper Nubia was equally important as it granted control over long-distance trade routes with the regions in southern Sudan and beyond which had already contributed to the wealth of the Kerman rulers (Bonnet, 2004b). The cultural and political significance of luxury goods, most importantly ebony and ivory, but also incense, animals, precious stones, animal skins or slaves becomes evident again through written sources documenting the exchange of those goods with rulers of the Western Asiatic Kingdoms. In addition, those goods also fulfilled important functions in Egyptian ritual life (Morkot, 2000: 78–80).

2.3.3. Egyptians in Nubia or Egyptianized Nubians – The Nubian population under New Kingdom control

2.3.3.i. The disappearance of the C-group

After the Egyptian conquest of Nubia, Lower Nubia saw an almost complete, rapid shift towards Egyptian cultural elements and disappearance of the local C-group people (Edwards, 2004: 107). This becomes particularly evident in the mortuary practices as indigenous burial rites seem to be almost suddenly replaced by Pharaonic Egyptian burial customs and material culture. By the middle of the 18th Dynasty, little is left to suggest the presence of any indigenous population features. The rapid shift in the material culture from Nubian to Egyptian was first noted by the archaeologists of the First Archaeological Survey of Nubia who concluded that this could be explained by major migrations of Egyptians to Nubia, entirely replacing the local population. Smith claimed that, *"in the times of the New Empire, Nubia was overrun with Egyptians, soldiers, administrators and other officials"* (Smith & Jones, 1910: 39). It was further assumed, that the local C-group people abandoned Lower Nubia and retreated to the south and desert regions.

This almost complete disappearance of indigenous Nubian culture, as well as the fate of the local Nubian population under New Kingdom Egyptian control, remains one of the central yet most debated themes of Nubian archaeology and history during the time of New Kingdom occupation (e.g. Trigger, 1965, Smith, 2003, Edwards, 2004: 107, Török, 2009, Van Pelt, 2013). Originating in cultural-historic traditions of early Nubian archaeology, two main theories have been put forward to explain the cultural developments taking place in Nubia at the beginning of the New Kingdom: complete replacement by Egyptian settlers or acculturation/ "Egyptianisation" of the Nubian population.

2.3.3.ii. A note on ethnicity

Because the conception of ethnicity and its manifestation in the archaeological record is central to any discussions about the historic and cultural developments in Nubia under New Kingdom Egyptian control, the theoretical foundations will briefly be introduced. Ethnicity is generally defined as the identification of a group based on a perceived cultural distinctiveness, expressed in social and psychological phenomena that make the group into a "people" (Jones, 1997: xiii, Robotham, 2014). An ethnic group refers to a group of people who set themselves apart and/or are set apart by others with whom they interact or co-exist on the basis of their perceptions of cultural differentiation and/or common descent (Jones, 1997: xiii). Individual identification with any such group is further termed ethnic identity (Jones, 1997: xiii). Identification of ethnicity in past human populations has traditionally been based on similarities in material culture (Jones, 1996). However, empirical evidence has repeatedly shown that there is not necessarily a direct correlation between ethnicity and material culture, leading to considerable debate about approaches to ethnicity in past human populations (e.g. Hodder, 1982, Shennan, 1989, Jones, 1996). Even though traditional archaeological views consider ethnic groups to be discrete or bounded entities that can be found in the archaeological record, there is emerging consensus that rather than static and absolute, ethnicity is highly dynamic and multi-dimensional, changing according to situation, context or individual choice (Jones, 1996: 64, 1997, Smith, 2003: 33). An important point is made by Jones in emphasizing that an understanding of past cultural contexts needs to be derived from a variety of sources, and incorporate a diachronic framework to identify shifts in the expression of ethnicity and the elements of material culture that represent it over time (Jones, 1996).

In ancient Egyptian political ideology, ethnic identity played a major role and served as a means of legitimizing power and authority of their kings (Loprieno, 1988, Smith, 2003: 21). Ethnic categories and stereotypes were created in order to define and set apart the “others” – the “Libyans”, the “Asiatics” and the “Nubians” – against a superior Egyptian ethnic group (Smith, 2003: 21). These stereotypes and associated symbolism finds ample evidence in Egyptian iconographic and textual sources (Kemp, 2006: 22-–23). These terms were even used archaically, referring to places and groups no longer in existence.

2.3.3.iii. Population replacement

The theory of complete replacement of the Nubian population was supported by the works of physical anthropologists such as Smith, Derry and Jones, who accompanied the archaeological expeditions to Nubia in order to investigate the large collections of skeletal remains excavated during these campaigns. Based on metrical analyses of skulls, Smith and Jones (1910) were the first who claimed the identification of Egyptian settlers buried at various New Kingdom sites in Lower Nubia. This was later emphasized by Batrawi (1935) working on the human remains excavated during the Second Archaeological Survey of Nubia as well as Vagn Nielsen (1970b) who studied the burials recovered during the Scandinavian Joint Expedition (SJE) based on his observation of marked differences in skull shapes between C-group and New Kingdom samples.

Based on archaeological evidence from Upper and Lower Nubia but also historic sources from Egypt proper, considerable movement of Egyptians to Lower Nubia and complete replacement of the local population now seems highly improbable (Morkot, 2000: 196, Török, 2009: 190). On the one hand the population in the Egyptian heartlands was simply not large enough to make emigration necessary or even sustainable (Török, 2009: 190). On the other hand, archaeological field work in the Upper Nubia and desert regions has failed to provide any evidence for the presence of C-group people (Säve-Söderbergh & Troy, 1991a: 8), as had been suggested by archaeologists of the First Archaeological Survey.

2.3.3.iv. Egyptianised Nubians – Assimilation, acculturation, hybridity?

With further archaeological field work during the Nubian campaigns of the 1960s, the replacement theory was increasingly put into question and archaeologists started to seek alternative explanations to account for the apparent disappearance of C-group people in Lower Nubia (Adams, 1964, Trigger, 1965). Bietak's analysis of C-group settlements showed that there was already a degree of Egyptian influence evident during C-group phase III, contemporary to the 17th Dynasty in Egypt and thus prior to the New Kingdom conquest of Nubia (Bietak, 1968). Consequently, researchers started to acknowledge that C-group peoples did not physically "disappear", but adopted pharaonic cultural elements to the extent that it made them completely indistinguishable from their Egyptian conquerors, both in terms of settlement patterns, grave types and also material culture (Trigger, 1965). Since then, cultural reasons rather than population movement underlying the disappearance of indigenous Nubian culture have become widely accepted, but the nature, modes of transmission, and extent of cultural change has remained the subject of research and varying interpretations (e.g. Smith, 2003, Edwards, 2004, Török, 2009, Van Pelt, 2013).

The complexity of Nubian-Egyptian interactions during New Kingdom occupation is well evidenced and a more nuanced view can be gained through the thorough examination of the rich archaeological record. Due to the large amount of archaeological data available for Lower Nubia, the process of acculturation is far better documented. While it has originally been argued for a rapidly occurring, complete replacement of local C-Group culture at the beginning of the 18th Dynasty, more recent publications of archaeological material from Lower Nubia contested this view, suggesting that Egyptianisation was a lot less universal and widespread as had been proposed earlier (Edwards, 2004: 107). The survey and excavations of the SJE provided evidence that not all elements of Nubian population were Egyptianized at the same time and to the same extent. Säve-Söderbergh (1989) reports a number of sites which provided evidence that, contrary to earlier notions, Nubian culture continued to exist well into the middle of the 18th Dynasty. Despite also clearly showing considerable Egyptian influence, sites like No. 176 also attest to the retention of Nubian elements and therefore suggest a much slower process of Egyptianisation than was originally postulated (Säve-Söderbergh, 1989: 200–205)

In addition, based on the evaluation of the large New Kingdom cemetery at Fadrus, Säve-Söderbergh & Troy (1991a: 8–9) argue that Egyptianisation was only superficial. This is exemplified by missing key elements of Egyptian funeral culture such as the complete lack of inscribed names of the deceased, even though one of the main purposes of an Egyptian burials was to preserve the name of the individual. In contrast, Smith (2003: 156–157) recently challenged this view, arguing that the lack of inscribed objects can be attributed to a lower social status.

One of the key sites in investigating and understanding the processes of "Egyptianisation" are the tombs of the Nubian princes of Tek-Khet in the Serra-Debeira region north of the 2nd Cataract (Säve-Söderbergh & Troy, 1991a), as well as those of the rulers of the Nubian state of Miam in the Toshka region (Steindorff, 1937). The princes were buried in lavish Egyptian style tombs decorated with hieroglyphic inscription and paintings and were provisioned with grave goods equivalent to those of elite burials in Egypt proper. Several of those indigenous princes are also well attested through Egyptian textual and iconographic sources where they are frequently represented delivering tributes to the pharaoh (Morkot, 2000: 81–85). Thus, despite being of Nubian origin, they clearly chose to display themselves as Egyptians in their tombs (Säve-Söderbergh & Troy, 1991a: 187–188). Furthermore, they may have played a major role in the gradual Egyptianisation of Lower Nubia, as these trends within the Nubian elite presumably were soon to be adopted by other parts of the population. (Edwards, 2004: 107). Bietak (1968) further suggested that the C-group culture had already lost most of its substance during its latest phase III shortly prior the New Kingdom conquest facilitating acculturation of the local elites. By that time, the C-group culture was already heavily mixed with external Kerman, Pan-grave and Egyptian elements, making them susceptible to Egyptian influence. In addition, Egyptian officials who continued to live in the Middle Kingdom fortresses (see above) may have also significantly contributed to the Egyptianisation of Nubia as well (Smith, 2003: 84–85).

Less is known about the cultural changes accompanying Egyptian colonial occupation in the province of Kush and the Kerman territories south of the 3rd Cataract. This bias can mainly be attributed to the lesser extent of archaeological work carried out on archaeological sites in Upper Nubia, the lack of systematic survey in the region (Smith, 2003: 87), and also to the lack of full publication of important colonial settlements such as Sai or Sesebi. In the northern part of Kush north of the 3rd Cataract, Egyptian presence was clearly marked by imposing temples and fortress towns erected at Amara, Sai, Seidinga, Soleb and Sesebi (O'Connor, 1993: 65). Those settlements would have housed the officials serving in the colonial administration as well as associated staff and military personnel, a number of which are attested through inscribed material recovered from some of these sites. Nevertheless, thus far little is known about the ethnic make-up and socio-economic structure of colonial communities settling in these towns.

Even though it has been suggested that the degree of acculturation was similar to Lower Nubia, it has also been recognised that the scale of these settlements is different to those in the Lower Nubia and the archaeological evidence to shed further light on these questions is, as yet, almost entirely missing (Smith, 2003: 94–95). It contrast to Lower Nubia, it has been argued that colonial control over the area south of the 3rd Cataract, within the Kerman heartlands was far less comprehensive and that the region remained largely autonomous (Morkot, 1991) but, again, the amount of archaeological research carried out in this area is not yet sufficient to support this proposition. Recent excavations at 3rd Cataract sites such as Tombos (Smith, 2003, 2007) or Hillat el-Arab (Vincentelli, 2006) are starting to reveal a much more complex mixture of Egyptian and indigenous cultural elements. Further sites featuring Egyptian ceramics were identified during extensive surveys in the region even though these are yet awaiting systematic excavations (Edwards, 2012). At those colonial settlements which are published, there is hardly any evidence that would suggest the presence of Nubian affinities. If ruling out large-scale population movement by Egyptians, one must assume Nubians or descendants of Egyptians already living in Nubia were settling in those towns (see Section 3.12). However, this picture is now slowly starting to change as there is evidence emerging to suggest that the apparent Egyptian character of the settlements is only superficial. One such example was the discovery of architectural elements within the settlement of Amara West which are typical of Kerma settlements but unknown in Pharaonic architecture (Spencer, 2010). Nubian pottery abundantly present at Amara West but also Sai (Budka, 2011) and Sesebi (Spence *et al.*, 2011) further points towards the continued existence of Nubian cultural practices.

2.3.3.v. The Nubian experience

Linked to discussions of Egyptian colonial strategies is the question of the role and experience of the Nubian population under Egyptian colonial rule and, as yet, very little is known about the nature and character of Egyptian colonial rule (Edwards, 2004: 110–111). Formal pharaonic textual narratives create the common view of a "wretched" population, almost being forced into mere slavery to serve the Egyptian rulers. Adams (1977: 166) claimed that under Egyptian rule Nubians became *fellaheen* after all control was passed into Egyptian hands. However, this strongly idealistic view almost certainly does not reflect reality. Archaeological evidence indicates that Nubians could rise to high ranks in the Egyptian administrative system both in the Nubian settlements but also in Egypt proper (Säve-Söderbergh, 1991, Smith, 2003: 22–23). The socio-cultural processes taking place in Nubia during the New Kingdom period can only be understood in light of the underlying colonial strategies and motivations. In traditional core-periphery models cultural processes are characterised as acculturation through comprehensive assimilation of new cultural elements from a dominant donor, with little difference remaining between donor and recipient at the end of the process (Smith, 2003: 258). Alternatively, within a less asymmetric distance-parity model, the cultural processes taking place can rather be seen as a deliberate, selective act of emulation and adaptation of material culture and new features (Smith, 2003: 258). The importance of the Nubian frontier communities in the Egyptian economy may have also provided them with considerable power. Smith emphasises the importance of individual agency rather than state dictates in day-to-day life.

Based on experience from cultural-contact situations in the Americas, Lightfoot and Martinez (1995) highlight the importance of such individual actions through social, kinship and political ties in border situations. Colonial populations, at least at the initial stages of settlements often comprise larger numbers of single men who are vulnerable to manipulation by native people, resulting in the construction of new identities beyond the simple blending of colonial and native lifeways.

Nevertheless, evidence from textual sources also indicates that relationships between the conquered Nubians and the conquerors were not always peaceful. There are reports of frequent rebellion in Upper Nubia throughout the whole time of the Egyptian occupation but increasingly from the 19^{th} Dynasty onwards (Morkot, 1991). The question of violent encounters between Egyptians and Nubians has also been addressed from a bioarchaeological perspective based on the occurrence of skeletal trauma in the human remains from Tombos (Buzon & Richman, 2007). However, this study failed to provide any evidence for interpersonal violence. Ongoing research at colonial sites such as Sai (Budka, pers. comm. 2013, 2014), Tombos (Smith, 2003) or Amara West (Spencer, 2012, 2014a) are now trying to shed light on questions about the fate of the local population and elucidate how colonisers and colonised lived side by side.

2.3.3.vi. Bioarchaeological evidence – New support for population movement?

With regard to the question of population movement to Nubia, even though large scale arrival of Egyptian settlers can now be ruled out, there is nevertheless evidence that at least some Egyptian individuals did move to Nubia. Fuelled by new data from the application of more recently developed analytical methods involving the study of stable strontium and oxygen isotopes, this problem has recently been re-addressed. Despite the known shortcomings of detecting ethnicity, Buzon (2006a) first applied craniometrical analysis to individuals recovered from the 18^{th} Dynasty colonial cemetery at Tombos. The results suggest a heterogeneous population living at Tombos, which is attributed to a mixture of people of Nubian and Egyptian origin. In order to test these findings, stable strontium and oxygen isotope analyses were carried out on the same sample, where certain outliers were detected, implying immigrants to the area (Buzon *et al.*, 2007). However, further analysis of carbon and oxygen isotopes, suggest that these people might not have necessarily come from Egypt (Buzon & Bowen, 2010). The high $\delta^{13}C$ values obtained for some of the individuals identified as outliers through their strontium isotope signatures, suggest a diet high in C_4-plants which would be highly unlikely in Egyptians at that time.

2.3.4. The later phase of the New Kingdom occupation of Nubia and the end of colonial control

Developments during the later phase of New Kingdom occupation up to the end of colonial control are still under debate (e.g. Török, 2009: 195–205). The 20th Dynasty has traditionally been described as a period of economic and demographic decline in Nubia, based on the lack of archaeological sites and the declining number of burials dating to the late New Kingdom (Trigger, 1976: 135–136, Adams, 1977). Firth (1912) and later Adams (1977) sought to explain the decline in population by lower Nile floods which resulted in a reduced flood plain and therefore reduced agricultural productivity. However, to date, there is no evidence supporting a significant decline in Nile floods during the later New Kingdom (Török, 2009: 201). Edwards (2004: 109) argues for a more general environmental decline and increased aridification of Nubia. This is supported by recent palaeoenvironmental research at Amara West (Spencer *et al.*, 2012). It was only recently acknowledged that the apparent lack of sites dating to the late New Kingdom might be the result of a combination of the uneven archaeological work or publication of excavated material and inherent difficulties in distinguishing late New Kingdom from earlier burials (Williams, 1992: 5, Török, 2009: 200–201). This may be related to a change of burial customs towards burial in large family vaults used over several generations, and provisioning the dead with small undatable objects, rather than with easily dateable household goods commonly provided for burials during the 18th Dynasty (see Chapter 3).

Others have linked the decline of Egyptian control over Nubia to general political and economical problems in Egypt proper (Török, 2009: 200–202). During the 20th Dynasty, royal power started to weaken considerably brought about by changing relationships between king, civil government and the army (O'Connor, 1983: 229). The breakdown of the New Kingdom state was further accelerated by uncontrollable migrations of people from the Eastern Mediterranean and increasing pressure of Libyan forces on Egypt's eastern borders (Török, 2009: 202–204). During the 2nd decade of reign of Ramesses XI (1107–1070BC), the last ruler of the New Kingdom, Panehesy the viceroy of Kush led a revolt against the Egyptian king but was forced to retreat to Lower Nubia. Nevertheless, he retained control over Lower Nubia despite it being unclear whether this was with Egyptian consent or that it was an independent polity (Török, 2009: 205–207). In addition to the political turmoil, surviving textual evidence suggests a decline in the production of gold in the Nubian mines which would have dramatically influenced the economic importance of Nubia and might have contributed to the abandonment of Lower Nubia (Trigger, 1976: 137, Morkot, 2000: 133–134). Occupation of Nubia was formally given up with the end of the New Kingdom around 1070BC.

2.3.5. The 9th/ 10th century BC – The "Dark Ages" of Nubia

The two centuries after the end of the New Kingdom occupation of Nubia have been the subject of considerable debate because, up until recently, sites dating to this period were largely missing (Morkot, 2000: 129). Most researchers accepted the common view that, with the end of New Kingdom occupation, the colonial settlements were abandoned and Egyptian settlers and administrators, as well as Egyptianized Nubians and their followers, went back to Egypt (e.g. Adams, 1964). The remaining population would have retreated to the Eastern desert or the regions of Upper Nubia and the entire area would have regressed into a "*tribal way of life*" (Trigger, 1976: 140). Only by the beginning of the 8th century with the rise of the second Kushite empire, known as the Napatan empire, do historic developments in Nubia become more visible again (Edwards, 2004: 113). Hence, an apparent gap of 200–300 years was created (Trigger, 1976: 150), often referred to as the "Dark Ages" (Adams, 1964, 1977, Morkot, 2000).

In order to explain this apparent abandonment of Nubia and the resulting void, various explanations have been put forward. Based on the low number of archaeological sites which can securely be dated to the late New Kingdom (see Section 2.3.4), it has been suggested that depopulation did not occur as one single, rapid event but had been already preceded by a general population decline during the 19th and 20th Dynasty (Edwards, 2004: 108–109). Equally, it has been noted that the low number of late New Kingdom elite burials suggests a gradual withdrawal of Egyptian officials that had already started during the 19th and 20th Dynasty. By the end of the 20th Dynasty, there seems to be little evidence left to support any significant settlement in most parts of Nubia (Edwards, 2004: 108–109). Only very recently, have some archaeologists (e.g. Morkot, 2000: 129–144, Török, 2009: 285–290) started to accept, that this apparent lack of evidence for any settlement activity might in fact be an interpretation based on a combination of several factors. This includes problems inherent to the dating methods applied to Nubian sites, leading to a failure to identify of sites dating to the 10th/9th century as well as the lack of insufficient publication of key sites such as Sai.

One of the key issues when investigating this time period is methodological, related to the often problematic practice of dating sites through pottery (Török, 2009: 287). Sites in Nubia dating to periods of Egyptian colonial control have traditionally been dated through the Egyptian style pottery recovered from them, related to well known sites in Egypt proper (Williams, 1992: 5–6). In Egypt proper, the chronology of the ceramics is established by relating the forms present with inscribed material referring to the reigns of kings for which dates are known from inscriptions. In addition, in both Egypt and Nubia, dating can of course be assisted or assured by inscribed material. As ceramic forms have proven to be very short-lived, this dating method has been commonly accept as a valid means of deriving a chronological framework for archaeological sites (Williams, 1992: 6). With regard to Nubian history, the method is reliable for the periods for which the pottery is well known, such as the New Kingdom period and the Napatan period, when Egypt was ruled by Nubian pharaohs during the 25th Dynasty and trade contacts were resumed (747–664BC). For the 10th and 9th century, when trade contacts with Egypt were interrupted and hence little pottery or inscribed material made its way to Nubia, this method becomes redundant. In addition, dating of the Third Intermediate Period in Egypt proper is still problematic in itself and is only now developing (Aston, 1996). Consequently, little is left that would allow an identification of sites in Nubia during the 10th and 9th centuries. Even though ceramic forms which are neither Egyptian New Kingdom nor fully Napatan have been noted on a few occasions such as at Sanam (Griffith, 1923) or at Missiminia opposite to Amara West on the south bank of the Nile (Vila, 1980), they only received little attention due to difficulties attributing to either of the two established phases.

An additional problem is posed by the fact that most theories fail to acknowledge that power in Upper Nubia remained largely within the hands of local Nubian chiefs throughout the New Kingdom. Despite the fact that archaeological evidence for settlement in Upper Nubia throughout the New Kingdom is still scarce, we nevertheless have to assume the presence of a significant local population (Morkot, 1991). Only recently did the existence of settlement activity during the 10th and 9th centuries become accepted by archaeologists, due to recent discovery of sites such as the cemeteries at Hillat el-Arab (Vincentelli, 2006), Sai (Thill, 2007), Tombos (Smith, 2007) and now Amara West (Spencer, 2009, Binder *et al.*, 2010, 2011). The sites provide undisputable evidence for the survival of communities living at the Egyptian sites after the end of the New Kingdom occupation, even though little is yet known about their make-up, size or structure. Consequently, the pottery associated with the 10th and 9th centuries may become better understood. An important new observation concerning post-New Kingdom material is the fact that it becomes more and more evident that much of the Egyptian style pottery found on New Kingdom sites is in fact not imported, but rather Egyptian forms produced locally. This has already been confirmed by petrographic analysis carried out within the framework of the Amara West project on sherds from the sites, proving that the clay used for the analysis is in fact local Nile silt (Millet *et al.,* forthcoming). Some of the New Kingdom forms such as beer jars and plates see slight alterations and adaptations due to local production and continue to be in use during the 10th and 9th centuries. Consequently, this might in the past have obscured evidence for post-New Kingdom occupation as the forms might have been attributed to the New Kingdom period.

New evidence brought about by recent excavations will also stir new discussion of the material discovered during old excavations and consequently lead to a re-evaluation of the archaeological record. Another important example is the large necropolis of Missiminia located opposite to Amara West (Vila, 1980). It was originally dated to the Napatan period by the excavators, a view that was generally accepted (Williams, 1993). However, a comparison with newly excavated material from sites such as Hillat el-Arab and Amara revealed striking similarities in the ceramic repertoire, which led to a reconsideration of the material. Thus, it has become increasingly acknowledged that the cemetery dates back to the 10thc century, possibly even to the late New Kingdom. The same can be said for the large cemetery of Sanam (Griffith, 1923, Lohwasser, 2008). It seems likely that with further field work in Nubia, together with a re-evaluation of material recovered during the 20th century, our knowledge about the historic developments that took place in Nubia during the 10th and 9th centuries will be greatly expanded and refined, closing the mysterious gap in Nubian history.

Having detailed the historic and cultural developments in ancient Nubia between 2500 and 800BC, the ancient settlement and cemeteries of Amara West will be introduced in the following chapter.

Chapter 3. Amara West

Figure 3.1 The archaeological site of Amara West (north top, image: Google Earth, 2009)

3.1. Location and topography of the site

The ancient settlement site of Amara West is located on the left bank of the River Nile, in a stretch where the river flows east-west, about 720km downstream of Sudan's modern capital Khartoum (see Figure 2.1). The settlement is situated on a low mound on the bank of the Nile. In ancient times, the settlement would be have been located on a small island surrounded by the Nile to the south and a palaeochannel to the north (Spencer *et al.*, 2012). The two cemeteries extend to the north-east (Cemetery C) and north-west (Cemetery D) of the settlement and would have been separated from the town mound by a west-east flowing palaeochannel (see Figure 3.1).

3.2. Pre-New Kingdom settlement activity in the area of Amara West

Owing to its position at the entrance to the relatively large fertile flood plain surrounding Sai, identified as the important Kushite settlement of Shaat (Gratien, 1978), considerable settlement activity around Amara West in the centuries preceding the New Kingdom occupation can be assumed (Edwards, 2004: 106). Arkell (1950) was the first to document a "robbed Nubian cemetery with Kerma sherds about a quarter of a mile north of the temple". A large number of Kerma settlements and cemeteries in the district of Amara/Abri (Vila, 1977b) were identified by the archaeological survey carried out by the French Centre National du Recherche Scientifique (CNRS) in 1971–1972 and 1972-1973. In the direct vicinity of the New Kingdom town, five cemeteries dating to the *Kerma moyen* and *Kerma classique* were noted. However, none of these sites has been subject to substantial excavations so far. A new survey carried out by Stevens in 2014 revealed evidence of small settlements or camps dating to the 18th Dynasty on the banks of a larger northern palaeochannel 2km north of the town (Stevens, pers. comm, 2014). While it is clear that the area surrounding the settlement was populated, no traces of any earlier, pre-New Kingdom occupation have been recovered from within the town itself until now.

3.3. The New Kingdom settlement

3.3.1. History of research

Archaeological research at the site was first carried out by archaeologists of the British Egypt Exploration Society (EES) in 1938 and 1939 led by A. Fairman and taken up again after World War II for three more seasons between 1947 and 1950 by P. Shinnie (Spencer, 1997: XXV–XXVI). During all of their campaigns work almost exclusively focused on the town site. The results of these excavations were never fully published by the original excavators and publications are confined to preliminary reports occurring in journals (Fairman, 1939, 1948, Shinnie, 1951). Only recently, P. Spencer of the EES undertook the task of publishing the whole corpus of documentation, and to date, two volumes have appeared: Amara West I on the town (Spencer, 1997) and Amara West II on the cemetery and pottery corpus (Spencer, 2002).

In 2008 a major research project focusing on both the town and the cemeteries was started by N. Spencer of the British Museum's Department of Ancient Egypt and Sudan (Spencer, 2009, 2012, 2014a). Since then, field work has been carried out annually, most notable uncovering a sizable Ramesside villa outside of the western town wall (Spencer, 2009), a structure potentially of Nubian architectural tradition (Spencer, 2010), as well as substantial housing areas within the fortified town spanning all phases of the town's occupation (Spencer, 2012, 2014a, b). Research within the settlement mainly focuses on aspects of urban life and domestic architecture, set within a framework of environmental and bioarchaeological research.

3.3.2. The settlement

The ancient settlement at Amara West has generally been recognised as the administrative capital of Kush, the province of Upper Nubia during the later half of the New Kingdom from the reign of Seti I (1285BC) until the formal end of New Kingdom occupation of Nubia in 1070BC (Spencer, 1997). Whether the site had already been occupied by then or was newly built, as would be suggested by stamps of Seti I on bricks used for the construction of the town wall, is yet unclear (Spencer, 2009). Monuments dating to the 18th Dynasty were recovered on site during the EES excavation even though these could have been brought from elsewhere (Spencer, 2009). Initially, the walled settlement, comprising an area of 11,600m^2 was built following a grid system with well-spaced buildings and a considerable number of magazines (Spencer, 2014c, b). In the north of the walled town, a series of buildings of high officials have been found, including a building identified by the EES through inscribed door jambs as the residence of the deputy of Kush (Spencer, 1997: 168). By the early 20th Dynasty, the character of the walled town changed considerably, perhaps as a consequence of a growing population (Spencer, 2014a). House sizes decreased considerably and alleys between houses got markedly narrower. The magazines also appear to have fallen out of use and were subdivided into smaller housing units.

At the end of Egyptian colonial rule over Nubia, the town was assumed to be abandoned by the Egyptian settlers (Spencer, 1997). However, some of the surviving structures may have continued to be used by the local population, as had already been observed by earlier excavators, even though they were not sure about the dating of this re-use. Fairman (1948) noted that the massive layers of sand between the latest Egyptian layers and the last occupation layer suggested a considerable time period between abandonment and re-use. Due to the lack of distinctive objects within this last level no conclusive dating could be obtained even though it was suggested that surface finds might indicate an early Napatan date. Continued occupation is further supported by large amounts of post-New Kingdom pottery on the surface of the town mound, with particular accumulations on the south and south-west side (Millet, pers. comm. 2012). Nevertheless, no intact occupation deposits post-dating the New Kingdom period have been identified (Spencer, pers. comm. 2014).

The object assemblage recovered from the settlement is of overwhelmingly Egyptian character (Spencer, 2014c) and is consistent with evidence from contemporary Egyptian sites (Kemp & Stevens, 2010a). The amount of Nubian objects is relatively small, comprising mainly ceramics, especially cooking pots. The proportion of Nubian artefacts notably increases towards the later phases of occupation of the settlement (Spencer, 2014c). However, this picture may likely be biased towards more durable materials while artefacts in wood or other organic materials, known to be common in Nubian contexts may not have survived.

3.4. Subsistence and environment

Today, Amara West is set within an arid, desert environment. Only a thin strip of river bank vegetation remains. Beyond, already engulfing the settlement and cemeteries, extends the Sahara desert. Within the framework of the Amara West Research Project, particularly within the Leverhulme Trust Project "Health and Diet in Ancient Nubia through climate and political change" (2010–2013) as well as a new AHRC project 2013–2016 "Sustainability and subsistence systems in a changing Sudan" led by Ryan, one of the major research aims has been the reconstruction of the ancient environment at Amara West. This includes palaeobotanical research led by Cartwright and Ryan (Department of Conservation and Scientific Research, British Museum) as well as geomorphological research by Macklin (Aberystwyth University) and Woodward (Manchester University).

3.4.1. The landscape and natural environment

The assumption that Amara West was founded on an island, surrounded by the main channel of the Nile to the south and the palaeochannel to the north was first noted by Fairman ((Fairman, 1939)Spencer, 2007) and subsequently by Vila (1977). However, intensive geomorphological research including OSL- and C^{14}-dates of deep sections and test trenches within the palaeochannel, and 2km to the north in another dried out branch of the Nile originally assumed to have dried up during the Neolithic, are now rapidly changing our perception of the ancient landscape in which people at Amara West would have lived (Spencer *et al.*, 2012). OSL-dating of sand deposits in a sondage in the palaeochannel directly to the north of the town indicate that the channel was already only occasionally carrying water by c. 1270BC (+/- 215), thus challenging early assumptions. By c. 205BC (+/- 180) the channel was completely dry.

Aside from decreasing the agricultural potential of the area, the cessation of the palaeochannel would have had other major impacts on life at Amara West. Strong northern winds carrying large amounts of desert sand and dust still prevail to the present day. In times when it was flowing, the riverbank vegetation, phytogenetic dunes, as well as the water itself, would have represented a major natural barrier protecting the town from the sand. Once this barrier was lost, blown sand potentially would have caused severe disturbance of life within the town. Architectural changes such as blocked doorways and barriers during the later phases of occupation of the town clearly represent human responses to protect the houses from incoming sand (Spencer, 2009, 2014b). New support for the hypothesis that sand increasingly became a major problem at Amara West comes from micromorphological analysis of deposits within an alley south of housing complex E13 (Dalton, Forthcoming). While the earliest layers are mainly made up by fine-grained silty material likely to consist of occupation debris and erosion of the mudbrick buildings, from occupation phase III (20th Dynasty) onwards they incorporate significant amounts of large-grained sand, presumably of aeolian origin.

In January 2013, renewed geomorphological fieldwork was carried in the palaeo-branch of the Nile 1.3km to the north of the site. Contrary to earlier assumptions that placed the drying out into the Neolithic period, OSL dates taken between flood layers in a sondage in this area revealed that it was still temporarily carrying water by the time Amara West was occupied (Macklin & Woodward, forthcoming). Based on these findings, the landscape surrounding the settlement would have rather comprised a system of channels and islands such as those seen further south around the 3rd Cataract (Macklin & Woodward, 2001).

Further sources of palaeoenvironmental data include wood, charcoal and plant macro-remains from the town and tombs. These include species typical of riverine habitats in semi-arid environments including sycamore fig, tamarisk, doum palm, Christ's thorn and Nile acacia. This slightly deviates from the vegetation spectrum present in the area today and points towards less arid conditions. While abundant in the archaeological material, sycamore fig, for example, is no longer present in this area.

3.4.2. Subsistence

The Egyptian economy was partly based on a complex state-run Egyptian system of re-distribution of agricultural produce administered by the temples. Consequently, based on textual records, it can be assumed that the development of agriculture and establishment of an economic system along Egyptian lines represented one of the main manifestations of Egyptian influence in the New Kingdom settlements in Nubia (Kemp, 1978). At Amara West, large magazines associated with the temple and Deputy's residence suggest similar strategies in place (Spencer, 2007: 53–74). However, some of these magazines fell out of use and were adjusted architecturally to give way for smaller housing units during the 20th Dynasty (Spencer, 2014a, b), potentially indicating changes to the significance of the Egyptian economic system.

The main body of data on subsistence strategies at Amara West so far comes from palaeobotanical research on plant macro-remains and phytoliths from selected contexts related to food-processing and storage, such as hearths, ovens and bins within the settlement (Ryan *et al.*, 2012, Ryan & Spencer, 2012). Climatic reconstruction suggests that at times when the palaeochannel would have still carried water, the area surrounding Amara West would have provided plenty of arable land. Charred plant remains and phytoliths so far indicate C_3-cereals emmer wheat (*Triticum dicoccum*) and barley (*Hordeum vulgare*) to be the main crops at Amara West (Ryan *et al.*, 2012). Archaeological evidence suggests that these crops had already "arrived" in northern Nubia during the Neolithic (Edwards, 2004: 14–15). In Pre-Kerman and Kerman period sites they are present, but little is known about subsistence strategies or their relative abundance and importance during those periods (Cartwright, 2001). Summer crops such as domesticated sorghum and millet or tropical grasses are almost completely absent from the palaeobotanical spectrum at Amara West. Phytoliths, and to a lesser degree charred macro-remains, suggest a small amount of wild grasses present within contexts related to food-processing or storage within the settlement (Ryan *et al.*, 2012). However, the small relative frequency of these remains argues against a significant importance of these plants, which is supported by evidence from stable carbon isotopes (see Section 9.12.1). The origins of summer wheat cultivation is still unclear (Edwards, 2007) but it appears to have occurred significantly later. To date, there is no secure evidence of domesticated sorghum predating the 1st millennium. The earliest evidence comes from the early Kushite layers at Kawa (Fuller, 2004) and only by the Meroitic period does sorghum become a common staple all over Northern Sudan. In addition to cereals, several types of fruits and vegetables were identified in the palaeobotanical record including sycamore fig, doum palm, white cross berry, Christ's thorn, colocynth, watermelon and further unspecified melon species.

With regard to animal husbandry, systematic archaeozoological research at Amara West is yet pending. However, the abundance of well preserved animal remains from within the settlement suggests a considerable amount of meat consumption on site. Preliminary analysis on faunal remains carried out in 2010 identified cattle, sheep/goat and pig making up the vast majority of the livestock present at Amara West, a pattern consistent with that found at contemporary sites in Egypt (Spencer, Clutterbuck, pers. comm., 2010).

3.5. The cemeteries of Amara West

3.5.1. Cemetery C

Cemetery C (E20.823341°, N30.385279°) is located to the north-east of the town, on a low alluvial terrace (see Figure 3.1). On the surface, the area is characterised by schist stone scatters representing deflated tumuli. Debris of human bone and ceramics surrounding the low mounds further indicates the presence of a cemetery. The area assumed to be occupied by graves is roughly triangular, extending 280m NNE-SSW and a maximum of 180m WNW-ESE and covers an area of 2.5ha. It is delimitated by a north-south running old wadi to the west, a schist stone escarpment to the east and the palaeochannel to the south. On the northern edge, the area is heavily disturbed by an irrigation project. However, since no ceramics or bones were visible anywhere in the area it remains unclear whether the cemetery extended that far north. The southern edge is truncated by the palaeochannel. Heavy surface erosion, deflating chamber tombs to only 0.40–0.50ms in remaining height, indicate that the palaeochannel was temporarily flooded even after people began building graves here.

A geomagnetic survey carried out by Hay (British School in Rome/ University of Southhampton) in 2008 covers most of the known cemetery area (see III.1). However, while reaching the slope of the escarpment to the western side, on the eastern side further graves are indicated through surface features beyond the surveyed area. The survey shows a dense swathe of 95–100 round to oval shaped features of varying sizes. If orientation could be inferred, it was E-W to ESE-WNW. Excavations have shown that these features indeed represent grave cuts. They by far exceed the number of surface features in this area. The excellent geomagnetic visibility of the grave cuts can be explained by the fact that the magnetically silent windblown sand backfilling the shaft strongly contrasts with the dense, alluvial silt in which the graves are cut. However, as windblown sand indicates looting, this may further imply that undisturbed graves – if we assume those to be backfilled with alluvial silt to be much harder, potentially impossible to detect. The presence of significant amounts of silt backfill has been observed in one niche burial (G237) so far.

3.5.2. Cemetery D

Cemetery D (E20.824749°, N30.384704°) is situated on a plateau on the desert escarpment to the north-west of the settlement. The area is elevated with respect to the town. The bedrock of the escarpment consists of schist, which crops out infrequently throughout the assumed cemetery area. The tombs, indicated by different surface features such as low circular mounds covered with schist stones representing tumuli or irregular mounds of schist rubble, are situated in shallower, sand covered depressions between the outcrops. Scattered human bones and ceramic fragments further allow for an identification of these features as tombs and also indicate looting. The exact extent of cemetery D is unknown at present. The area assumed to be used for burial extends 320m E-W to 200m N-S. On the northern side, the area is demarcated by a rocky ridge, to the southern and eastern side surface features end at the slope of the escarpment. A geomagnetic survey carried out on the southern slope in 2008 did not reveal any further graves. On the western side surface features extend until the plateau starts dropping off. However, the identification of these features as tombs is not certain, as only some display human remains while others also display animal bones. Moreover, towards the western side, the surface features are more clearly defined circles of schist stones. The discovery of a similar structure, revealed to be a tumulus of Kerma ancient date (G308) in 2010 in the central part of Cemetery D warrants attention, and similarities clearly argue for a significantly early date of the tombs on the western side. In 2010, a geomagnetic survey was again conducted in the western half of the cemetery area (see III.2). Around 45–50 well visible elongated, oval-shaped grave cuts were detected in the survey. In contrast to Cemetery C, the majority of these features are significantly larger. Orientation was again mostly E–W to ESE–WNW. A second geomagnetic survey carried out by Hay in 2014 revealed two more large mud brick structure on the eastern side of the escarpment, situated on the highest and most prominent location. Pressumably these represent further funerary monuments even though their exact nature will have to be clarified in forthcoming seasons.

The location of both cemeteries to the north of the palaeochannel is significant because it may reflect an adherence to Egyptian belief systems. As can be observed in many sites in Egypt proper, the west bank was the preferred place for burial due to its association with the afterlife (Richards, 2005: 79). Due to the local course of the Nile from east to west, the location on the north bank at Amara West correlates with this pattern.

3.6. History of research in the Amara West cemeteries

3.6.1. The EES excavations 1938–1939

The cemeteries were briefly investigated by the EES during the last days of the 1938–1939 season (Fairman, 1939). However, in contrast to the settlement, very little attention was paid to the cemeteries and consequently the recording of the cemetery excavations is very poor. The location of the graves was not recorded at all. This can partly be attributed to the fact that although originally not intended, during the last few days of the season of 1938/39, Fairman sent out his Egyptian workmen to excavate a few graves in order to keep them busy while the British Egyptologists rushed to complete epigraphic recording in the temple (Spencer, 2002: 2). The records mention 32 excavated graves in total ranging from simple pit graves to large chamber tombs with substantial mudbrick superstructures within the shafts. All the tombs were noted as being robbed. Based on the burial styles, types and richness in grave goods, six were assigned to the New Kingdom and nine tombs were assigned to the "X-group", a cultural complex of the post-Meroitic period dating to between 350 and 550AD (Edwards, 2004: 185–190). The additional ones remained undated.

Tombs 101, 102, 103, 104, 106 and 112 (see Figure 3.3) were originally dated to the 19th Dynasty by the excavators (Spencer, 2002: 5–8, pls. 2–11, 14). P. Spencer (2002: 3) however suggested a re-dating of the tombs to the Napatan period based on the comparison of the finds with finds from the cemetery of Missiminia on the opposite bank of the Nile (Vila, 1980). The second group of tombs were dated to the "X-group" and are all single burials (Spencer, 2002: 8–10, pls 12–16). Only five of them contained undisturbed or partly undisturbed human remains, with three of them being flexed burials and two of them extended. Of these nine graves, only seven contained a few finds and sherds. In Tomb 105G it is noted that there was the base of a New Kingdom pot. Tombs 105 B, C and E contained hand-made Nubian sherds. The X-group date is highly questionable and seems in fact very unlikely as there are no finds that could argue for that dating. Single pit burials, flexed as well as extended, are commonly found at Soleb or Qustul, and thus it is reasonable to assume those single burials as being contemporary.

3.6.2. The CNRS survey 1973

In 1973, a survey by a team of the French CNRS (*Centre National de la Recherche Scientifique)* also excavated graves in four different localities in the vicinity of the town which were assumed to date to the New Kingdom or Napatan periods (Vila, 1977b: 28–33). Site 2-R-8 was dated to the New Kingdom and is most likely to be identical to Cemetery C of the present project. Only one tomb was explored at that site. Similar to other graves at the site, it consists of a rectangular, east-west orientated shaft of 1.50m in depth with two burial chambers on the east and west side of the shaft. It was disturbed and a number of vessels and sherds were recovered which led the archaeologists to assume a dating to the New Kingdom period (Vila, 1977b: 28–31).

Site 2-R-9, where the CNRS team excavated two graves, is also located within Cemetery C, south of 2-R-8, but was dated to the X-group based on the orientation and structure of the tombs (Vila, 1977: 32–33). However, even Vila was not sure of this dating. While 2-R-9/2 was an empty rectangular N-S-orientated pit, 2-R-9/1 of the lateral-niche type, was orientated NNE-SSW and had a niche cut into the east side of the shaft at a depth of 0.85m. The niche was covered with a schist-slab and contained the disturbed remains of only one individual. No finds were recovered from this burial. Within Cemetery D, the CNRS team excavated a further three graves (Site 2-R-56). While two of them were single infant burials, one (2-R-56/1) was a larger, E-W-orientated niche-grave with remnants of mudbrick superstructure preserved on the northern side of the shaft. This grave contained the disturbed skeleton of one individual as well as a few sherds of which one was of Nubian type (Vila, 1977b: 61‑62). The survey mentions one more site designated as a New Kingdom cemetery to the east of the site (2-S-35) where they excavated two graves which were dated to the Kerman period, with a suspected reuse during later time periods.

3.6.3. The British Museum Amara West Research Project 2008 –

Field work was taken up again in 2008 by a team from the British Museum led by Neal Spencer of the Department of Ancient Egypt and Sudan. During the first short field season, field work in the cemeteries only comprised a geomagnetic survey in Cemetery C. Excavations in the cemeteries were started in 2009 under the supervision of the author and have since been carried out annually. Field work has alternated between cemetery areas. Cemetery C was investigated in 2009, 2011, 2013 and 2014, while work in Cemetery D took place in 2009 (initial field walking and small-scale test excavations), 2010 and 2012. To date a total of 52 graves were documented and are shown Table 3.1 and Table 3.2.

3.7. General overview

The following section provides a detailed discussion of the architecture of the graves recorded in Cemetery C (see Figure 3.2) and Cemetery D (see Figure 3.3) at Amara West between 2009 and 2013. A summative description of each grave including finds and burials is given in Appendix II.

		Chamber tombs			Niche burials	Total
		Single	Double	Multiple		
Cemetery C	**n**	1	6	1	30	**38**
	%	2.6	15.8	2.6	78.9	
Cemetery D	**n**	5	9	0	0	**14**
	%	35.7	64.3	0.0	0.0	
Total	**n**	**6**	**15**	**1**	**30**	**52**
	%	**11.5**	**28.8**	**1.9**	**57.7**	

Table 3.1 Total number of graves excavated in cemeteries C and D (up to and including 2013)

		Chamber tombs			Niche burials	Total
		Single	Double	Multiple		
New Kingdom	**n**	1	5	1	0	**7**
	%	14.3	71.4	14.3	0.0	
Post-New Kingdom	**n**	5	10	0	29	**44**
	%	11.4	22.7	0.0	65.9	
Total	**n**	**6**	**15**	**1**	**30**	**52**
	%	**11.5**	**28.8**	**1.9**	**57.7**	

Table 3.2 Total number of graves by time period (up to and including 2013)

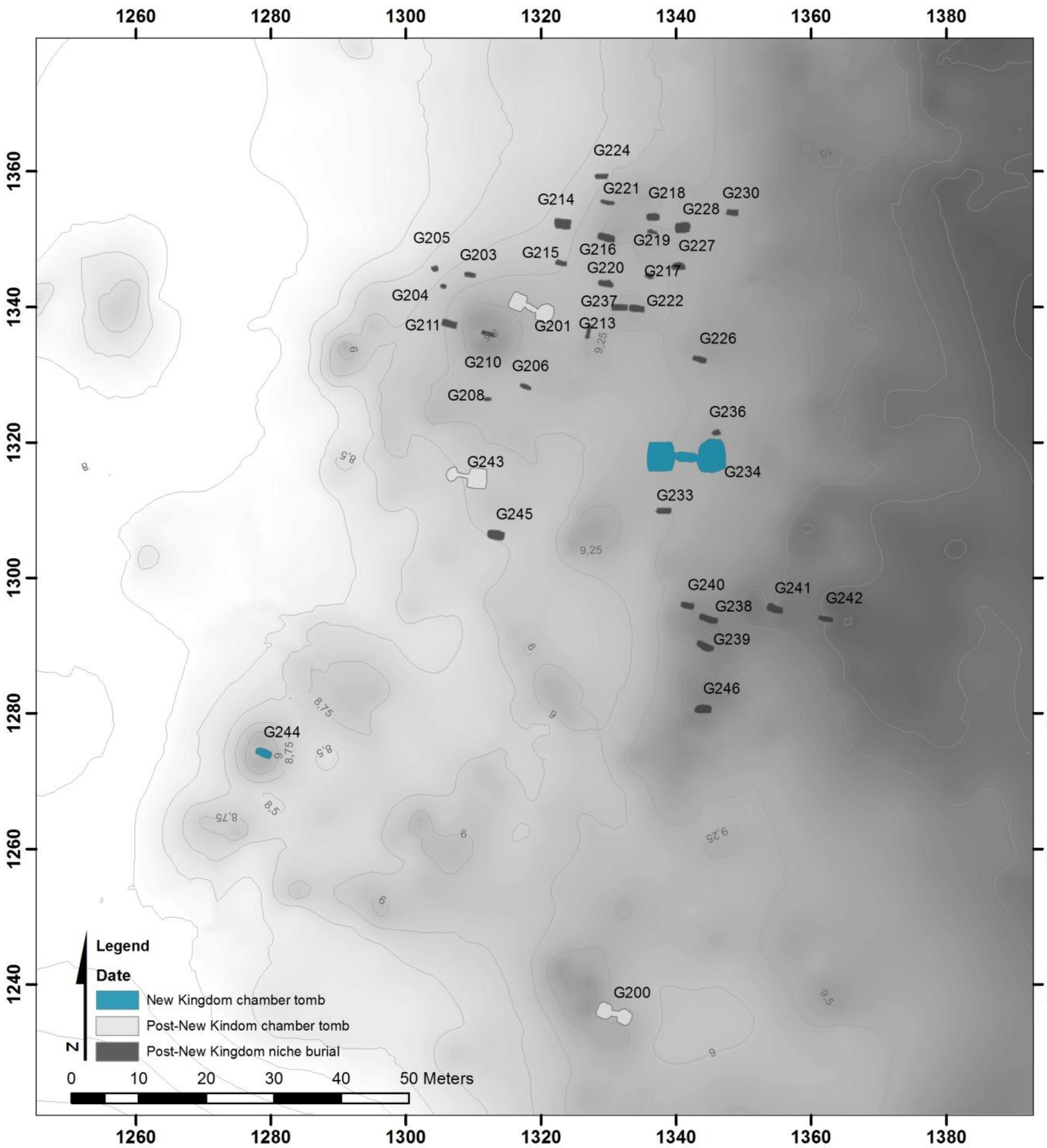

Figure 3.2 Graves excavated between 2009 and 2013 in Cemetery C (created by M. Binder)

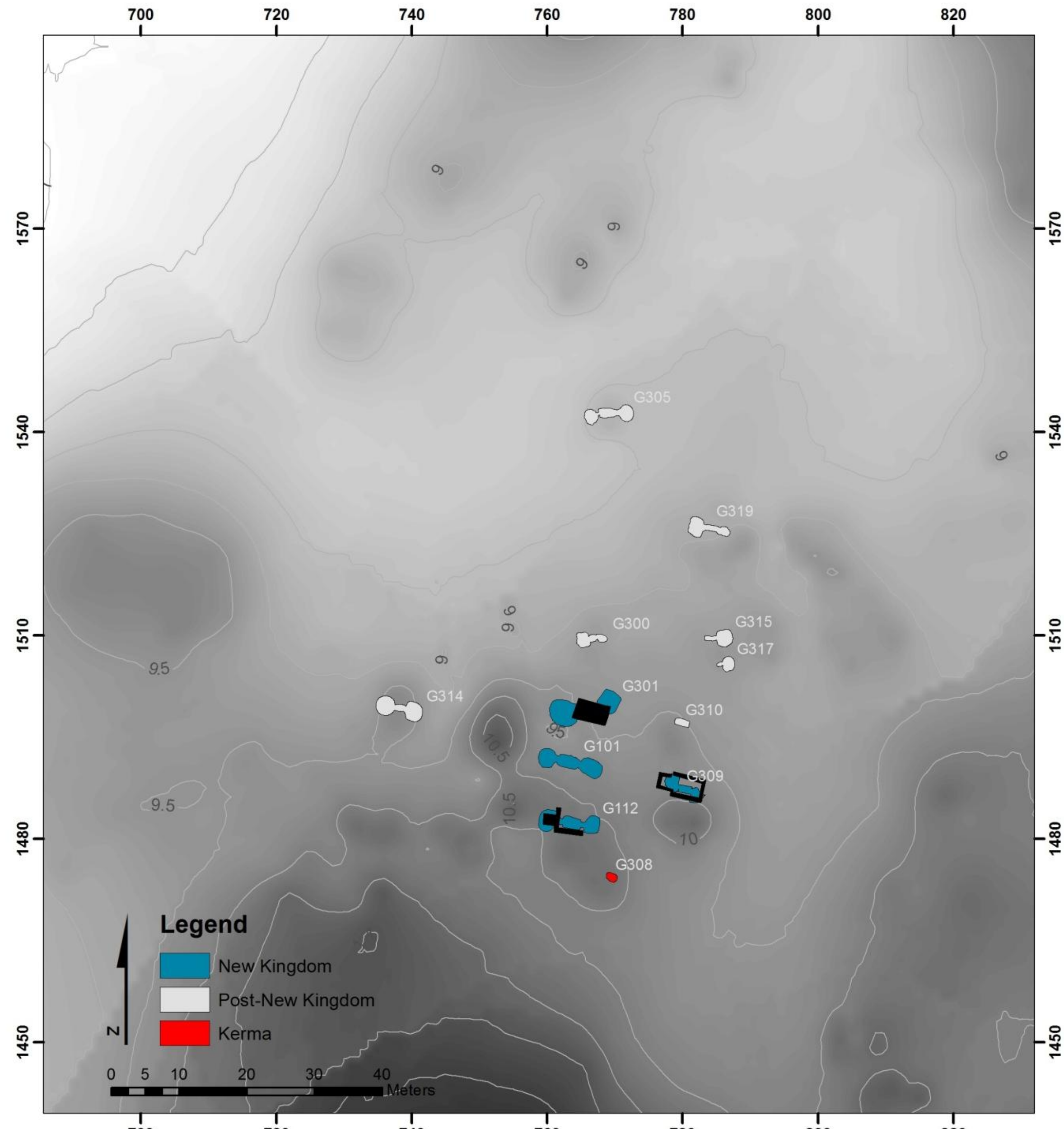

Figure 3.3 Map of the western area of Cemetery D with graves excavated between 2010 and 2013 (created by M. Binder)

3.8. Architecture of the graves

3.8.1. Chamber tombs

3.8.1.i. General remarks

The underground chamber tomb represents one of the two main forms of substructure at Amara West both during the New Kingdom and post-New Kingdom period and can be found in both Cemeteries C and D. While the sub-structures are very similar in architectural layout, significant differences were observed with regard to the presence and type of superstructures, which may reflect differences in social status but also cultural preferences. The sub-structures will be discussed together in Section 3.8.1.vi but the superstructures will be described separately in the following.

3.8.1.ii. Pyramid superstructures

	Cemetery C	Cemetery D
New Kingdom	-	G112 (excavated by the EES, Spencer, 2002), G301, G309
Post- New Kingdom	-	-

Table 3.3 Overview of pyramid tombs

Three tombs, all located in Cemetery D and dating to the New Kingdom period, feature superstructures constructed from mudbrick (see Figures III.3–III.5, Table 3.3). The principal component of this type of superstructure is a rectangular, east-west aligned chapel surrounding the shaft and enclosing an area of 12.3 (G301) to 16.5m^2 (G309). The walls, with a thickness of 0.60m are heavily eroded in all examples and only preserved to a maximum of three rows of crude mud bricks (brick dimension consistently around 38x20x8–9cm). The outer walls were covered with crude mud mortar on the outer of the walls, traces of paint were not observed in any of the examples. Inferences about the height or shape of the roof are impossible to make in the absence of any related architectural elements. However, findings of vaulting bricks and mortar remnants in comparative superstructures on other contemporary sites suggest that these chapels would have featured a vaulted roof (Schiff Giorgini, 1971: 81, Fig. 119, Polz, 2007: 241, Minault-Gout & Thill, 2013: 10). Attached to the western side of the chapel of G112 and G309 is a small rectangular mudbrick wall preserved to only one to two courses of brick (G112: 1.50m EW x 1.35 NS; G309: 1.90m EW x 2.0m NS). Based on comparison with other contemporary sites (e.g. Schiff Giorgini, 1971: 81,

Fig. 119, Smith, 2003: 141, Fig. 6.4, Minault-Gout & Thill, 2013: 10), they can be identified as the base of a small pyramid. The pyramids may have been constructed with a mudbrick coat covering a rubble core, or provided the base for a pyramid constructed from another type of material.

This type of superstructure is a common feature of non-royal elite burials in New Kingdom cemeteries throughout Egypt proper and Nubia, as far south as Tombos. The architecture of the tombs, with close links with temple architecture, emphasised the parallelism between the cult of the gods and that of the dead (Taylor, 2001: 137). In Nubia, this architectural form is well exemplified by the tombs at Soleb (Schiff Giorgini, 1971), Sai (Minault-Gout & Thill, 2013), Sesibi (Fairman, 1938, Edwards, 2012: 80-–83), Tombos (Smith, 2003) or at Aniba in Lower Nubia (Steindorff, 1935). The chapels had a central role in the Egyptian funerary cult and were used for the performance of rituals to ensure rebirth and nourishment of the dead (Taylor, 2001: 137). Therefore, they were present even in very modest burials. The focal point of the chapels in contemporary cemeteries may have been a stela or offering table (Schiff Giorgini, 1971: 83, Minault-Gout & Thill, 2013), even though remnants of such features are yet to be found at Amara West. Examples at Thebes (Polz, 2007: 241-243) or Deir el-Medineh show that these chapels may have also been lavishly decorated. However, no traces of any painted decoration were recovered at Amara West to date. The pyramid represents an integral part of elite Egyptian funerary culture from the Old Kingdom onwards, even though only during the New Kingdom it ceased to be confined to royalty and became part of private tombs too (Taylor, 2001: 137). The importance of such solar iconography is evident even in very modest burials which could be accompanied by a triangular-topped stelae, as in the South Tombs cemetery at Tell el-Amarna (Kemp, 2008).

Despite including the two major components of typical New Kingdom elite superstructures, the tombs at Amara West somewhat deviate from examples recorded at other sites. The most notable difference is the small footprint of the pyramid bases. While at Thebes or Aniba the pyramids were large enough to serve as the cult room, the smallest pyramids at Sai have a base length of 2.64m while those at Soleb are at least 2.35m in length (Schiff Giorgini, 1971: 82, Minault-Gout & Thill, 2013: 10). Small platforms were documented at Aniba and interpreted as symbolic representations of pyramids, which despite their size, still retained their cultic functions (Steindorff, 1937). Comparable structures were observed in the non-elite South Tombs cemetery at Tell el-Amarna (Kemp, 2008). However, other pyramid tombs at Nubia date to the 18th

Dynasty. It appears possible that the small footprint of the pyramids at Amara West reflects a departure from original Egyptian models. The tombs at Amara West were built 150 years after the Egyptian conquest, at a time when the cultural models and patterns originally introduced from Egypt perhaps had become somewhat altered and diluted. Courtyards or enclosures which are a third main component often observed in pyramid or chapel tombs, such as at Buhen (Randall-MacIver & Woolley, 1911: 137), Soleb (Schiff Giorgini 1971, 82–3), Sai (Geus 2004, 116, figs. 90, 91), and Tombos (Smith 2003, 138–43) or Thebes (Polz, 2007: 241), are also notably absent from Amara West.

In all cases, the shaft providing entrance to the substructure was located in the centre of the chapel. Large stone slabs placed above the shaft as a cover have only been documented in G112 excavated by the EES (see Figure III.5). This practice finds parallels at Soleb (Schiff Giorgini, 1971: 85) and Buhen, Cemetery H (Randall-MacIver & Woolley, 1911).

3.8.1.iii. Chamber tombs with tumulus superstructures

	Cemetery C	Cemetery D
New Kingdom	G244	-
Post- New Kingdom	-	G300, G305, G314

Table 3.4 Spatial and chronological distribution of chamber tombs with tumulus superstructures

Four chamber tombs at Amara West were marked on the surface by a tumulus superstructure (see Table 3.4). The tumuli are relatively similar in construction details as they are all made of nile silt and designated on the surface by a loose scatter of small to medium size schist stones (see Figure III.6). Diameters range between 18m (G244) and 6.5m (G300). With the exception of G244, featuring five burial chambers (see Figure III.7), the substructures all comprised an eastern and a western burial chamber extending from a rectangular shaft. The tumulus represent one of the hallmark features of Nubian funerary ritual from the 3rd millennium BC onwards (Bonnet, 1999). The substructures of traditional Nubian tumulus graves however are markedly different and usually comprise simple pits. Chamber tombs such as at Amara West are completely unknown from indigenous Nubian contexts. In contrast to the relatively conformist pyramid tombs featuring a predefined set of components, combinations of chamber tomb substructure and tumulus are rare and much more enigmatic. Only a small number of these tombs, all dating to the New Kingdom period have been documented in Nubia to date. Besides Amara West, examples have been found at Serra East (Williams, 1993), Ginis West (Vila, 1977a) and perhaps Sesebi (pers. observation, 2012). However, at each of these sites a somewhat different configuration of architectural features can be observed. The tombs at Serra East feature low tumuli made of rubble thrown up from the shaft, with rectangular mud brick chapels on the east side of three of them (Williams, 1993: 151). Two of these graves also had enclosure walls. At Sesebi the superstructures appear to feature mud brick chapels on top of a raised mound (pers. observation). Unfortunately, further details about these important tombs remain unclear due to the fact that the graves excavated by the Egypt Exploration Society in 1937/38 (Fairman, 1938) have never been published (Edwards, 2012: 80).

3.8.1.iv. Chamber tombs with vaulted structures in the shaft

	Cemetery C	Cemetery D
New Kingdom	-	G101
Post- New Kingdom	-	G305

Table 3.5 Chamber tombs with vaulted structures in the shaft

Vaulted mudbrick structures constructed inside the shaft were found in two chamber tombs in Cemetery D (see Table 3.5), even though they significantly differ from each other in construction details and size. In G101, excavated by the EES in 1938 and later re-cleared for documentation in 2010, the substantial, east-west aligned structure reaches a height of 1.98m (see Figure III.8, III.9, III.11). The barrel vault, constructed of two rows of mud bricks (32x16–17x6cm) covered the western two thirds of the shaft (3.2x1.6m, depth: 2m) and sits upon a northern and a southern mudbrick wall (see Figure III.8). Its outer and inner sides were coated with a thick layer of mud plaster (2–3cm); schist stones and sherds were used as keystones. No vault was provided over the eastern end of the excavated chamber, thus creating a shaft through which the subterranean spaces could be accessed.

The structure in G305 is considerably smaller, only reaching a height of *c.* 1.10m. In contrast to G101, the pointed vault is only built from one row of thin bricks and rests on mudbrick walls of 0.70m height built against the north and south wall of the shaft (see Figures III.10, III.11, III.12). The eastern and western side with entrances to the two burial chambers are also lined with mudbricks.

Vaulted structures are generally common in cemeteries within the Egyptian cultural sphere from the New Kingdom onwards, and were either found as chapels above the shaft (e.g. Bruyère, 1924, Polz, 2007: 241, Abb. 62) or comprising the actual burial chamber constructed inside a burial pit (e.g. Peet, 1914: 85, Fig. 46, Brunton & Engelbach, 1927). Of the latter type, a large number of New Kingdom tombs exemplifying the development from vault lined rock cut chambers to free standing vaulted burial chambers inside a pit during the period were documented in Abydos (Peet, 1914: 90–91). Entrance to these chambers was provided through a vertical, often brick-lined shaft. In Nubia, vaulted funerary chapels comprising a central component of pyramid tombs are well evidenced at New Kingdom sites such as Aniba (Steindorff, 1937), Sai or Soleb (Schiff Giorgini, 1971). Vaulted burial chambers are a common feature of the Lower Nubian New Kingdom sites (e.g. Emery & Kirwan, 1935, Säve-Söderbergh & Troy, 1991a, Williams, 1992) but also at Sai (Gratien, 2002) and Tombos (Smith, 2003), and continue to be popular well into the post-New Kingdom and Napatan periods as is evident at Missiminia (Vila, 1980).

At Amara West, it remains unclear whether these vaulted structures in the shaft were intended for burial. Due to the stability of the surrounding alluvium, a function as re-inforcement of the shaft walls also seems highly unlikely. In G305, four individuals were recovered from within the shaft. However, these are fully disturbed and it remains unclear as to what extent these are contemporary with the construction of the tomb or represent later re-use. In G101, excavated by the EES, skeletal remains were not documented. Comparative examples have not been found, to date. The tombs at Amara West with vaulted structures occupying the vertical shaft of chamber tombs appear to be an unusual variant, combining traditional Egyptian components of funerary architecture in a new way.

3.8.1.v. Chamber tombs without superstructure

	Cemetery C		Cemetery D	
	Single	**Double**	**Single**	**Double**
New Kingdom	-	G234	G319 (W)	G316
Post- New Kingdom	-	G200, G201, G243	G315 (E), G317 (E)	

Table 3.6 Single and double chamber tombs without superstructures

Simple single or double-chamber tombs without superstructures were present in both cemeteries (see Table 3.6). However, interpretation of the absence of superstructures is somewhat problematic given the extensive surface erosion in cemetery C. Simple chamber tombs are a common feature of cemeteries all over Nubia and of course in Egypt proper. The size of the burial chambers is relatively varied. Some of the tombs found at Fadrus or Wadi es-Sebua are just about wide enough to provide space for one or two burials, hence being referred to as end niches rather than chambers (Säve-Söderbergh & Troy, 1991a: 216) and leading Emery & Kirwan to call them a "poor copy" of the Egyptian shaft tomb (1935: 487). As a consequence of the small size, the bodies are all orientated W–E, with the head to the west in the vast majority of cases (Säve-Söderbergh & Troy, 1991b: Pls 105–148). In terms of the number of chambers, at Fadrus the vast majority of graves feature only one side niche/ chamber (Säve-Söderbergh & Troy, 1991a: 216). This stands in contrast to Qustul, Adindan (Williams, 1992: 21) or Amara West.

3.8.1.vi. Substructures

	Shaft size (m^2)				Shaft depth (m)				Chamber size (m^2)			
	Max.		Min.		Max.		Min.		Max.		Min.	
	C	D	C	D	C	D	C	D	C	D	C	D
New Kingdom	2.6	2.2	1.2	1.9	2.6	2.1	1.70	1.7	7.0	7.6		3.6
Post-New Kingdom	2.5	4.1	0.8	0.8	2.1	2.0	0.30	1.3	6.7	5.0	2.4	2.5

Table 3.7 Range of burial number, shaft and chamber dimensions (m^2) in the chamber tombs of Amara West (C=Cemetery C, D=Cemetery D)

While there are considerable differences in superstructures, the substructures are all relatively similar in layout (see Figure III.13). Therefore, the features common to all chamber tombs will be discussed here together (see Table 3.7). Burial chambers used for the interment of multiple individuals, usually families, become a common form of tombs of both elite and non-elite backgrounds in Egypt from the Middle Kingdom onwards (Richards, 2005). At the same time, they also start occurring in Nubian sites related to Egyptian occupation (Williams, 1992: 3). During the New Kingdom period, they become a typical feature of sites of Egyptian cultural affiliation from the 18th Dynasty onwards and find close parallels in all Lower and Upper Nubian sites related to Egyptian occupation such as at Qustul (Williams, 1992), Fadrus (Säve-Söderbergh & Troy, 1991a), Serra East (Williams, 1993), Sai (Minault & Thill, 1974), Soleb (Schiff Giorgini, 1971) or Tombos (Smith, 2003, 2007).

In all examples entrance to the substructure is provided by a rectangular, vertical E-W aligned shaft (see Figure III.13). This again corresponds with the typical Egyptian form in contemporary cemeteries both in Nubia (Schiff Giorgini, 1971, Säve-Söderbergh & Troy, 1991a, Williams, 1992, Minault-Gout & Thill, 2013) and Egypt proper (e.g. Bruyère, 1924, Brunton & Engelbach, 1927). In Cemetery C, the tombs are exclusively carved into the alluvial silt. In the New Kingdom tombs in Cemetery D, the chambers are partially carved into the schist bedrock, while the post-New Kingdom chamber tombs documented in this area so far are shallower and carved into the alluvial silt. In terms of size and depth there is again considerable variation at Amara West (see Table 3.7). However, in Cemetery C inferences about shaft depth are difficult to draw since there appears to be considerable surface deflation due to wind erosion. With regard to size of the shaft, there appears to be an underlying chronological trend towards somewhat smaller shafts during the post-New Kingdom period.

The chamber tombs recovered at Amara West so far are consistently aligned according to the magnetic east-west axis. This conforms to the traditional Egyptian pattern originating in the strong cosmogonic symbolism of Egyptian funerary ritual (Taylor, 2001: 138) and also corresponds to orientation patterns in other Nubian sites. With the exception of G244, featuring five burial chambers, the number of chambers varies between one (six examples) and two (15 examples, see Table 3.2). This is also consistent with most other New Kingdom sites in Nubia. Contemporary tombs with multiple chambers, such as G244, are by far less common and have so far only been reported at Buhen (Randall-MacIver & Woolley, 1911) and Hillat el-Arab (Vincentelli, 2006) even though the latter are entirely rock-cut and therefore of a somewhat different character.

The burial chambers are always located on the eastern and/or western side of the shaft even though there are some marked variations in size and construction details which are worth closer examination. According to Egyptian funerary customs, burial chambers were traditionally situated on the western side of the shaft (Taylor, 2001). In the New Kingdom pyramid tombs in Cemetery D, the eastern chambers are considerably smaller and only very crudely carved when compared to the western chamber, indicating that they represent secondary additions. This is supported by the fact that ceramics from these chambers are only of post-New Kingdom date even though, in light of heavy disturbance, this has to be viewed with caution. In the single-chamber New Kingdom tomb G319, featuring a chamber on the west, the eastern side of the shaft shows initial traces of a carved door, but the process appears to have been abandoned for unknown reasons. Such clear architectural differences cannot be observed in the New Kingdom tombs in Cemetery C. In the post-New Kingdom tombs, the reverse trend can be observed with larger and more elaborately carved chambers on the eastern side. In the post-New Kingdom single-chamber tombs in Cemetery D, the chamber was located twice on the east side and twice on the west side. The construction of chambers on the eastern side only therefore may be interpreted as a departure from original Egyptian funerary customs, and perhaps serve as an indicator of the hybrid culture that developed in New Kingdom sites during Egyptian occupation of Nubia. Other New Kingdom cemeteries in Nubia reflect a very similar pattern. At Soleb, eastern chambers were only found in conjunction with western burial chambers (Schiff Giorgini, 1971: 85).

With regard to layout, the burial chambers at Amara West are all relatively similar in floor plan, ranging from sub-circular to rectangular. However, there is considerable variation in size, number of chambers and number of interments. In terms of size, the largest chambers occupy a ground area of $7.6m^2$, while the smallest are only $2.4m^2$. Several reasons could account for these differences. Status has been shown to be a possible influence in burial size. At Amara West, status is somewhat difficult to infer because of the lack of intact burial contexts due to ancient and modern looting. The presence of certain types of superstructures (see Sections 3.8.1.ii, 3.8.1.iii and 3.8.1.iv) certainly indicates an elite background for the tomb owners. However, the burial chambers do not differ in size from the burials without superstructures. Chronological position also does not seem to influence grave size as equally large chambers were constructed during the post-New Kingdom period. In addition, while variation is evident within both cemeteries, no clear differences can be observed between cemetery C and cemetery D. There is also no correlation between the size of the chamber and the number of interments made within them (see Table 3.8).

	max		**min**	
	C	**D**	**C**	**D**
New Kingdom chamber	13	5	8	2
Post-New Kingdom chamber	37	15	4	2
Post-New Kingdom niche	7	-	1	-

Table 3.8 Number of interments in chamber and niche burials

Additional architectural features of the sub-structures which were recorded in almost all tombs are blocking structures used to seal the narrow, rectangular doorways to the burial chambers (see Figures III.14–16). These range in height from between 0.70 (G243) and 1.50m (G244). Sealing structures of varying degrees of preservation were documented in all graves, but only three of them could be considered largely intact.

Different types of material were used for those blocking structures. While some were sealed using large, vertically placed schist or sand stone plates attached to the walls using mud plaster, other graves had blocking walls constructed from mudbrick or combinations of mudbrick and small schist slabs. This variation again does not follow any clear underlying pattern, as none of the types is confined to a chronological period or correlated with a type of superstructure and therefore may rather be subject to factors such as individual choice or availability of material.

3.8.2. The Niche burials

3.8.2.i. Niche burials without superstructures (see Table 3.9)

	Cemetery C	Cemetery D
New Kingdom	-	-
Post- New Kingdom	G203-206, G208, G210-212, G214– 220, G222, G224, G227, G230, G233, G237, G245	-

Table 3.9 Niche burials with superstructures

Burials of this type feature a rectangular or oval-shaped, lateral side niche on the bottom of a rectangular burial shaft (see Figures III.17–21). The niches are either cut into the northern (21 graves, 72.4%) or the southern side (eight graves, 27.6%) of the shaft. The size of the shaft is usually similar to the size of the burial niche. In the majority of cases only one burial was made in the niche. Entrance to the niches was usually blocked by structures comprising single large or rows of smaller schist plates sealed together by mud plaster (see Figure III.20). In G210, a large inscribed sandstone lintel , most likely removed from the town where similar lintels decorated house doors, was used for blocking (see Figure III.21).

Orientation		Total graves	Females	Males	Indifferent
North	n	21	12	8	16
	%	72.4	33.3	22.2	44.4
South	n	8	4	3	8
	%	27.6	26.7	20.0	53.3
Total	n	29	16	11	24

Table 3.10 Orientation of the niche burials and demographic distribution of individuals

Orientation of the burial niches varied between the north and south sides of the shaft. The reasons for these differences remain unclear. No clear correlation was found between orientation and sex or age of the individuals buried in the niche burials (see Table 3.10). Due to the high degree of looting it was also not possible to detect any correlation with the distribution of grave goods, which could indicate some underlying socio-cultural factors governing grave orientation. Moreover, no spatial patterning was observed as both types seem randomly distributed throughout the cemetery. Variation in niche orientation between north and south has also been noted in other cemeteries such as at Sanam (Lohwasser, 2010: 41) or Missiminia (Vila, 1980: 22). Similar to Amara West, no explanation accounting for this variation has been found, to date.

With regard to body position, all intact or partially intact individuals were buried in extended position even though in several cases such inferences were not possible due to disturbance of the burial. Orientation of the body could only be inferred in 12 of 52 individuals and was again variable due to the high degree of disturbance. All individuals were orientated east-west, with the head east in five and west in seven individuals. Again no clear spatial pattern or correlation with grave goods or demographic parameters could be observed. Burials in south-facing niches were only orientated west-east even though this is only based on individuals from one grave (G239) and therefore may not necessarily be representative.

Rectangular niche tombs with extended burials are very common in almost all New Kingdom cemeteries in Lower Nubia. Reisner described them as one of the five main New Kingdom tomb types (Reisner, 1910: 303, Fig. 260, New Empire type III), frequently reported in most of the cemetery sites dating to the New Kingdom period recorded during the First and Second Archaeological Surveys of Nubia (Emery & Kirwan, 1935: 486, Type D3) as well as at Fadrus (Säve-Söderbergh & Troy, 1991a: 215). Smaller numbers were also recorded at Qustul (Williams, 1992: 202, 223). Interestingly, they are notably absent from the Upper Nubian New Kingdom sites. However, the New Kingdom niche burials from lower Nubian sites are somewhat distinctive from Amara West in consistently featuring a flat floor in contrast to the stepped profile with lowered burial niche found in the later burials. Stepped niche burials like those seen at Amara only occur in Nubian cemeteries from the post-New Kingdom period onwards and find close parallels at Missiminia (Vila, 1980: 22), Sai (Geus *et al.*, 1995) and Sanam (Lohwasser, 2010: 41-–42).

After the end of the New Kingdom period, niche burials get increasingly common and become a regular feature of cemeteries dating to the Napatan period. However, their precise dating remains questionable in the light of new results from Amara West, and in fact a large number of them may already date to the 10th and 9th centuries BC. Those cemeteries tentatively dating to the post-New Kingdom period include Missiminia where simple niche burials make up 35% of all the burials (Vila, 1980). Early, potentially contemporary niche burials were also recorded at Sai (Geus *et al.*, 1995).

3.8.2.ii. Niche burials with superstructures

	Cemetery C	Cemetery D
New Kingdom	-	-
Post-New Kingdom	G210, G226, G238, G238-G242, G245, G246	-

Table 3.11 Niche burials with superstructure

A small number of niche burials in Cemetery C featured small circular superstructures constructed from silt and decorated with circular scatters of schist plates (see Table 3.11, Figure III.22). The largest example is G210 with a tumulus of 9m diameter. As has been outlined in Section 3.8.1.iii, the tumulus represents an important feature of Nubian funerary culture. The significance of differences in use of superstructures in the niche burials remains unclear. While it is possible that differential preservation may account for the absence of superstructures in some niche burials, it may also reflect differences in social status. The substructures of G210, G238, G239 and G240 also differ markedly in size from the majority of niche burials. These tombs also stand out in terms of elaborateness of blocking structures, most importantly the large sandstone door lintel with hieroglyphic inscriptions taken from the settlement and re-used for blocking in G210. In addition, they feature a relatively higher number of grave goods including more valuable objects such as carved ivory objects (G238, G240) even though, due to the high degree of disturbance, this is again difficult to prove with any more certainty.

Tumuli do not represent a standard feature of niche burials of the post-New Kingdom and Napatan period. At Sanam, Sai or Missiminia they were entirely absent. Whether this could also be explained by surface deflation remains unclear. However, at Tombos rock-cut examples associated with tumuli were recorded which also stand out in terms of size of substructure and grave good assemblage, indicating a higher social status (Smith, pers. comm., 2011). The most prominent examples of large niche burials featuring tumulus superstructures are tombs in the royal cemeteries of El-Kurru, Ku. Tum.1, Ku. Tum 5, Ku. Tum. 6, thought to represent the tombs of the earliest Kushite rulers in the 9th century BC (Dunham, 1950: 128). However, there remains considerable doubt about their dating (Kendall, 1999: 298--304, Török, 2009), thus they may in fact not be related to the Napatan phase of use at all (Edwards, 2004: 118).

3.9. Funerary ritual

3.9.1. Orientation of the body

			NS	SN	EW	WE	Total
Chamber tombs							
New Kingdom	**C**	**n**	6	3	2	0	11
		%	54.4	27.3	18.2	0	
	D	**n**	3	1	0	0	4
		%	75.0	25.0	-	-	
Post-New Kingdom	**C**	**n**	11	3	4	4	22
		%	50.0	13.6	18.2	18.2	
	D	**n**	9	3	3	4	19
		%	47.4	15.8	15.8	21.1	
Niche burials							
Post-New Kingdom	**C**	**n**	0	0	5	7	12
		%	-	-	41.7	58.3	
Total Chamber tombs		**n**	**29**	**10**	**9**	**8**	**56**
		%	**37.7**	**17.9**	**16.1**	**14.3**	
Total Niche burials		**n**	**0**	**0**	**5**	**7**	**12**
		%	**-**	**-**	**41.7**	**58.3**	
Total burials		**n**	**29**	**10**	**14**	**15**	**68**
		%	**42.6**	**14.7**	**20.6**	**22.1**	

Table 3.12 Orientation of burials as Amara West (n= number of individuals)

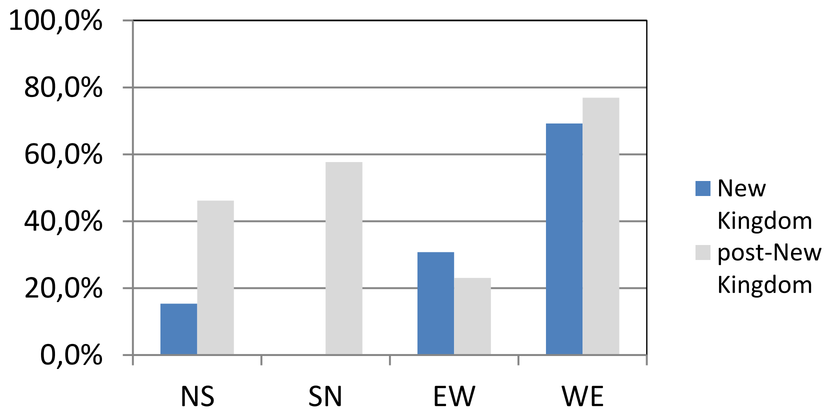

Figure 3.4 Distribution of body orientation in New Kingdom and post-New Kingdom burials

Body orientation has been a central aspects of funerary ritual throughout human history, usually originating in strong cosmological symbology inherent to many belief systems (Parker Pearson, 1999: 54). At Amara West, the study of body orientation and funerary ritual as well as potential diachronic or cultural differences therein are limited by the extensive degree of disturbance of burials. With regard to body orientation, inferences could only be drawn for 68 out of 180 individuals (37.8%). The results show a generally high degree of variation (see Table 3.12 and Figure 3.4). In the chamber tombs, a north-south orientation represents the predominant orientation, with the head to the north in 37.7% and to the south in 17.9%. This is particularly evident in the New Kingdom burials, where only two individuals deviate from this rule. E–W aligned burials become more frequent in the post-New Kingdom, accounting for a third of burials in chamber tombs. In the later niche burials, body orientation is exclusively E–W.

The N–S orientation conforms to traditional Egyptian funerary ritual. According to Egyptian belief, the north-south orientation allowed the deceased to face east towards the rising sun, symbolising re-birth, and away from the west, the realm of death (Taylor, 2001: 138). Nevertheless, there is considerable variation in orientation, particularly in non-royal burial grounds and both N–S and E–W orientation are commonly observed in Pharaonic cemeteries in Egypt proper (Hulková, 2013: 35). In many places, the Nile was used as the main reference point for orientation of the burial (Taylor, 2001: 138). Variations in the course of the Nile may also account for differences in burial orientation. The variability in body orientation can similarly be observed in Nubian New Kingdom sites. While at Tombos (Smith, 2003), Soleb (Schiff Giorgini, 1971) and Wadi es-Sebua (Emery & Kirwan, 1935) burials are exclusively E-W orientated, both forms can be observed at Sai (Minault-Gout & Thill, 2013) or Qustul (Williams, 1992), even though at all sites the Nile runs in a south–north direction. Because the Nile runs W-E at Amara West, a N-S orientation would correspond to the E-W orientation observed at other sites. Nevertheless, orientation of the sub- and superstructures follows the true orientation at Amara West. In Nubian funerary tradition, orientation is a lot less variable, with strict E–W (head east) alignment being observed in Kerma cemeteries from the earliest phases onwards (Geus, 1991). Only in Lower Nubia, C-group people started to adopt a N–S orientation from the Middle Kingdom period onwards too which was interpreted as a sign of increasing Egyptian influence.

Even though the underlying reason for the variability at Amara West and other sites remain unclear, the gradual shift in orientation for N–S to E–W, culminating in the niche burials which represent the last phase of burial at Amara West, certainly indicate fundamental changes in funerary culture occurring at Amara West during the post-New Kingdom period.

3.9.2. Body position

		Extended		Flexed		Total	
		C	D	C	D	C	D
New Kingdom	n	23	4	0	0	23	4
	%	100.0	100.0	-	-		
Post-New Kingdom chamber	n	24	26	1	2	25	28
	%	96.0	92.9	4.0	7.1		
Post-New Kingdom niche	n	9	0	0	0	9	0
	%	100.0	-	-	-		
Total burials	n	56	30	1	2	57	32
	%	96.6		3.4			

Table 3.13 Body position of burials at Amara West (dating refers to individuals, not graves)

The positioning of the body represents another main parameter of funerary ritual (Parker Pearson, 1999: 6). Due to the strong dichotomy between traditional Egyptian extended and flexed Nubian burial, body position has often been used as an indicator of Egyptian influence in discussions of the relationships between the two cultural spheres (e.g. Bonnet, 1999, Smith, 2003: 162–165, 2007). The flexed body position (see Figure 3.5) can be traced in Nubia back into prehistoric periods (Geus, 1991). In Upper Nubia it remained the exclusive body position until the Egyptian conquest during the New Kingdom, while in Lower Nubia (Bonnet, 1999) extended burials start occurring in C-group cemeteries from the 2nd Intermediate Period onwards and represent a sign of increasing Egyptian influence in the area (Bietak, 1968). After the start of New Kingdom occupation of Nubia, extended burials rapidly become the predominant position while contracted burials disappear almost completely. Only during the Napatan period, do

Figure 3.5 Flexed burial Sk234-1 (post-New Kingdom?)

flexed burials together with other traditional Nubian funerary elements such as tumuli become more frequent again even though extended burials remain equally popular. Large contemporary groups of both types at Sanam or Meroe were interpreted as a sign of the presence of different ethnic groups at those sites (Griffith, 1923: 87, Dunham, 1963, Bonnet, 1999).

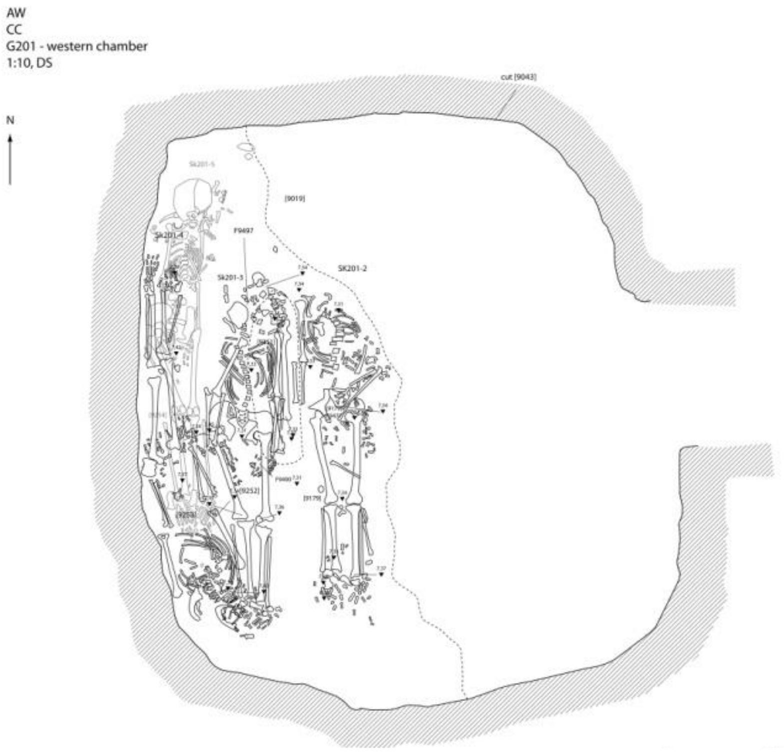

Figure 3.6 Extended burials (Western chamber of G201, post-New Kingdom)

The patterns observed at Amara West (see Table 3.13), with the vast majority of all individuals being buried in an extended position (see Figure 3.6), are therefore consistent with the general trend in New Kingdom Nubia even though again the picture gained from the cemeteries may not necessarily be fully representative due to the large number of disarticulated burials. Body position could be ascertained in only 35% of individuals recovered at Amara West up until now. Only three examples of flexed burials have been found at Amara West so far, all deriving from chamber tombs dating to the post-New Kingdom period. Two flexed burials, an old adult woman and a one to two year old child are from the same tomb chamber. The third flexed burial, a middle adult woman was recovered in the entrance to a burial chamber on 30cms of windblown sand, stratigraphically higher than the remainder of individuals and thus potentially representing later re-use of the chamber (see Figure 3.5). The timing of this re-use remains unclear, even though the fact that the person was buried in a doum palm coffin similar to those found in association with individuals assumed to represent primary post-New Kingdom burial phases, suggests a certain degree of contemporarity. Occasional findings of flexed burials are not unusual in New Kingdom cemeteries and are interpreted as a sign of traditionalism or even resistance to the culture of the conquerors (Bonnet, 1999: 166, Smith, 2003). An interesting observation is the fact, that similar to Amara West, all four flexed burials at Tombos were females, leading Smith to conclude that women were more culturally conservative than men (Smith, 2003: 165–166).

3.9.3. Treatment of the body

Inferences about body treatment are again limited by the high degree of disturbance but also general preservation on site. Material evidence for wrapping of the burials was only recovered with a small number of individuals (see Figure 3.7). Nevertheless, the position of the bones in articulated burials with verticalisation of clavicles, short distance between humeri of both body sides, and close alignment of the small bones of the hand and feet (Duday, 2009) provides further strong evidence for tight wrapping of the burial. The occasional observation of prone burials further supports this suggestion as it may be explained by the fact that in wrapped burials distinguishing between the upper and lower side of the corpse was not possible anymore. Archaeobotanical analysis of the textile fragments indicates the use of different materials, mainly flax as well as nettle and wool (Hacke, unpublished report. 2013). However, preservation of the textile remains was so poor that only three samples yielded definite and two more, possible results. Secondary evidence for the presence of fine textiles surrounding the body comes from impressions on plaster fragments (see Figure 3.8). The fragments indicate that plaster would have been applied to the coffin when wet, entering the interior and spilling onto the dead body.

Figure 3.7 Remnants of matting associated with Sk314-11 (post-New Kingdom)

Figure 3.8 Impressions of textile on plaster fragments (G300, post-New Kingdom)

3.9.4. Funerary containers

Type of funerary container		New Kingdom	Post-New Kingdom	
		Chamber tomb	Chamber tomb	Niche burials
No container	**n**	9	6	7
	%	22.0	7.1	13.0
Coffin undecorated	**n**	7	8	0
	%	17.1	9.4	-
Coffin decorated	**n**	13	4	7
	%	31.7	4.7	13.0
Funerary bed	**n**	0	2	4
	%	0.0	2.4	7.4
Doum palm coffin/ wrapping	**n**	2	11	0
	%	4.9	12.9	
Wrapping	**n**	0	5	4
	%	-	5.9	7.4
Funerary container unidentifiable	**n**	1	18	19
	%	2.4	21.2	35.2
Undetermined	**n**	9	31	13
	%	22.0	36.5	24.1
Total		**41**	**85**	**54**

Table 3.14 Funerary containers used at Amara West

Due to differential preservation and post-depositional disturbance during looting and re-use, insights into the use of funerary containers are again somewhat limited (see Table 3.14). Even though fragments of wooden objects were recovered in most tombs, it was not always possible to associate them with an individual. In general, three main types of containers could be observed at Amara West: wooden coffins, a type of coffin or wrapping made from doum palm bark, and funerary beds.

Wooden coffins were by far the most common type of identifiable funerary container (see Figure 3.9, Table 3.14). They represented the predominant form of funerary container during the New Kingdom period but also remained popular during the later phase of use of the cemeteries. The coffin represents the single most important object in Egyptian funerary ritual throughout the entire Pharaonic period and took a central role in Egyptian belief in the afterlife (Taylor, 2001: 214). Aside from protecting the body from disturbance and disintegration, it symbolised the eternal environment of the deceased, often manifested in lavish pictorial displays on the in-and outside of high-status Egyptian coffins (Taylor, 2001: 215–216). At Amara West, the coffins were mainly constructed from the wood of the sycomore fig, a locally available tree providing timber of relatively low quality (Cartwright, 2014). Non-local types of wood, such as cedar imported from Lebanon, which would have indicated procurement of coffins from Egypt proper, have not been found, to date. However, a detailed analysis of all the coffins is pending. The shape of the coffins is difficult to determine due to the poor state of preservation. During the New Kingdom, elite Egyptian coffins predominantly would have had an anthropoid shape (Taylor, 2001: 226). In only one example at Amara West (G244), can such a shape clearly be proven, based on the presence of well preserved rounded coffin elements. Nevertheless, it seems likely that at least the decorated coffins would have had a similar shape.

Figure 3.9 Wooden coffin F9457 in G216 (Cemetery C), insert: detail of painting

The coffins were either plain or decorated with painted plaster (see Figures 3.9, III.34–35), even though again it is often difficult to discern whether the absence of plaster is real or due to poor preservation. Due to their symbolic significance in the Egyptian belief system, the decoration of Egyptian coffins followed a set decorative program, including a number of magic spells for the benefit of the deceased in the afterlife (Taylor, 2001: 222). During the 19th and 20th Dynasty, the coffin lids would have represented the deceased as a living person, wearing a festal wig and dressed in linen clothes (Taylor, 2001: 224). At Amara West, the decoration on the coffins was very poorly preserved with only traces of paint surviving in the vast majority of examples. Consistent with Egyptian forms, the predominant colours are yellow, black and red. Blue was also observed but appears to have different properties which left it more prone to deterioration. As a consequence, in only very few instances could coffin parts with more distinctive patterns be discerned. The most important example is the face mask on the coffin of Sk309-7, a young adult female buried in the western burial chamber of

G309 (see Figure III.33). The associated pottery assemblage (see Figure III.36) suggests a dating of the original phase of the burial to the 20th Dynasty. Conforming to Egyptian tradition, the person depicted on the lid features a black wig and a head-dress crowned with a lotus flower. The face is painted red, with yellow earrings on either side. This somewhat deviates from standard Egyptian patterns, as the red colour was typically used for male coffins, but is found occasionally in female coffins (Cooney, 2010, Bettum, 2012: 56, 69, 195). Of the body, only parts of a floral collar and few sections on the side were preserved (see Figure III.34, III.35), and the remainder of the lid was badly destroyed by ceiling collapse. Only a few coffin faces from New Kingdom Nubian sites have survived. The most elaborate examples were documented in the tombs of the Princes of Tek-Het (Säve-Söderbergh, 1991), one more example comes from Fadrus (Säve-Söderbergh & Troy, 1991a: 56), and several were found at Aniba (Steindorff, 1935: 71, 72; Taf. 40, 5 and 6).

Other important examples are the coffins found in the tumulus tomb G244. Due to preservation again no clear iconographic decorations were preserved. Despite some relatively large fragments, decorations recovered from the tomb are confined to patterns (see Figure III.26). A large fragment from the western central chamber bears yellow and black stripes, a pattern that is commonly found on the side of panels of later New Kingdom coffins (Taylor, pers. comm, 2013). However, despite generally conforming to Egyptian style the decorations on the coffins at Amara West are also of relatively simple craftsmanship. While overall the Egyptian influence is clearly visible, the observed patterns somewhat deviate from what was to be expected in a traditional Egyptian environment and it appears plausible that the coffins at Amara West represent local imitations (Taylor, pers. comm. 2013). The only figurative depiction discovered in a disturbed context in a post-New Kingdom chamber tomb further highlights this claim as it shows the head of an Egyptian-style falcon-headed god but appropriated in a Nubian style (see Figure III.42). Similar patterns can be observed elsewhere in New Kingdom cemeteries in Nubia. The most important example are the coffins of the Nubian princes at Debeira East. While superficially resembling Egyptian coffins, their decoration and illegible hieroglyphic inscriptions again represent Nubian imitations (Taylor, 2014).

With regard to their chronological distribution, painted and unpainted coffins were used throughout the time period of use of the cemeteries. Whether the absence/presence of decoration on coffins can be used as an indicator of social status also remains unclear because the absence of plaster may well be due to poor preservation. The almost complete absence of plaster in large chamber tombs such as G234 and G243 is nevertheless notable.

Burial beds, on the other hand, are a traditional element of Nubian funerary customs which first appears at the end of *Kerma ancien* and become a very common feature of Kerma burials (Geus, 1991). At Amara West, they appear to be less common than coffins (see Table 3.14). However, the majority come from disturbed chamber tombs and it is difficult to determine their precise number. Their presence can only be established based on the findings of fragments of bed legs, terminals or elements with traces of stringing (see Figures III.45, III.51, III.54) which only allows for inferences about minimum numbers of beds present in each chamber. Only three relatively intact examples (one from a chamber tomb, (see Figure 3.10) and two from niche burials) can be documented, to date. With regard to construction details, again the level of preservation limit more comprehensive inferences. Amongst the most common bed elements are elements of the frame which in several examples still retain remnants of tight rows of stringing, with a string of ~5–6mm in diameter preserved (see Figure 3.10, insert). Similar practices are still employed in the making of contemporary Nubian beds. Bed terminals were made in different shapes, some of them decorated with intricate carvings. Despite preservation issues, some conclusions can be drawn. With regard to diachronic distribution, so far there is no conclusive evidence for the use of funerary beds from New Kingdom contexts. At least one burial bed was present in the eastern chamber of the New Kingdom pyramid tomb G309, even though both the ceramic assemblage, as well as the architectural layout, suggests that the chamber represent a post-New Kingdom addition (see Section 3.8.1.vi).

Figure 3.10 Funerary bed in G314 (post-New Kingdom), insert shows detail of stringing


Figure 3.11 Doum palm coffin of Sk317-2 (post-New Kingdom)

The third main and most simple form of funerary containers are coffins or wrappings made from doum palm bark. Wood of the doum palm is very light, flexible but of relatively poor quality and would have been available abundantly in the area of Amara West. The exact shape of these containers remains unclear but in some well preserved complete examples (see Figure 3.11), tapering on the head and foot end indicates a type of matting in which the body was wrapped rather than placed in a coffin. Similar containers made from a type of plant fibre represented the most common type in the low status South Tombs cemetery at Tell el-Amarna (Kemp *et al.*, 2012). With regard to their diachronic distribution, they appear to be predominantly a feature of post-New Kingdom burials. Their significance for identification of social status is further difficult to determine. However, it is notable that they are entirely absent from the niche burials even though wooden remains were recovered from the majority of niche burials. This may on the one hand represent a culturally induced preference for different types of funerary containers, but on the other hand any such claims are difficult in the absence of comparative cemeteries. It may also be attributable to environmental reasons.

Unanswered remains the question as to what factors governed the choice of different types of funerary containers. During the New Kingdom period, coffins generally represent the predominant form of funerary container, with richly decorated coffins likely being an attribute of burial of people of higher social class. In the post-New Kingdom period, a lot more variation is observable. The co-occurrence of coffins, beds and doum-palm coffins in chamber and niche tombs in general, sometimes even within individual tombs, either argues against cultural affiliation as the main parameter determining type of funerary contained used, or indicates a high degree of individuality. While social status may be related to the use of simple doum palm coffins, it cannot account for the choice of coffins vs. funerary beds. It therefore remains possible that the type of funerary container used for burial was simply subject to individual choice.

3.9.5. Grave goods

3.9.5.i. General remarks

Due to extensive looting of the graves, the funerary assemblages recovered from the tombs at Amara West are most likely incomplete. This is further aggravated by preservation issues because evidence from some contexts suggests a substantial number of objects placed in the graves was made from organic materials such as wood, reed or leather. Taphonomic issues seem to have been particularly detrimental in Cemetery D because, aside from badly deteriorated wooden coffins, no organic finds were recovered from rock cut tombs, in contrast to the silt cut chamber tombs in Cemetery C. Therefore, inferences about grave good assemblages and their interpretation for cultural affiliations or status can only be made to a very limited extent. Only a small number of burials can be assumed to be intact. A detailed discussion of the types of grave goods recovered from Amara West is beyond the scope of this thesis. An overview of main categories of grave goods and their distribution between different grave types and time periods is provided in Table 3.15. Nevertheless, a few general observations about the configuration of the assemblages and how they fit into the wider regional context can be made.

The most abundant category of materials found in the graves is pottery (see Section 3.9.5.iv), which conforms to general patterns in contemporary Nubian sites (e.g. Säve-Söderbergh & Troy, 1991a, Williams, 1992). This may be explained by disturbance of the tombs. On the other hand, in Egypt proper funerary ritual of the 19th and 20th Dynasties is generally marked by a significant decline in the number of grave goods, a trend observable in both elite and non-elite contexts (Smith, 1992, Grajetzki, 2003: 89–90). The configuration of grave goods was also subject to considerable changes throughout the New Kingdom. During the 18th Dynasty, objects of "daily life" comprising elements of furniture, games, tools or jewellery accounted for a large proportion of funerary equipment. Some of these objects would have been used throughout life (Taylor, 2001: 110). During the later phase of the New Kingdom objects specifically designed for the grave such as funerary amulets become the main category of grave goods (Smith, 1992). A clear distinction however cannot always be drawn as some objects may have fulfilled everyday as well as symbolic functions. The assemblage of grave goods at Amara West generally mirrors contemporary Egyptian assemblages throughout the time period of use, even though it comprises both artefacts of everyday and specialised funerary nature, contrasting trends in Egypt proper.

3.9.5.ii. Specialised funerary equipment

3.9.5.ii (a) Amulets

In Egyptian funerary ritual, specialised objects played an important role because of magical powers assigned to them to protect to the dead in the afterlife (Taylor, 2001: 200). Funerary amulets were amongst the most common of these magical objects. Their function and potency was dependent on form, colour and material. At Amara West, the most frequently recovered type of funerary amulet were scarabs, with 26 examples found to date. In a funerary context, the scarab was associated with the sun god and also represented the notion of rebirth, and its popularity is well attested in Egyptian cemeteries and graves regardless of social status (Taylor, 2001: 205, Grajetzki, 2003: 52). However, aside from naturalistic scarabs, they were not originally specialised funerary objects *per se*. In life, they would have been used as impression seals (Andrews, 1994: 52). At Amara West, this is nicely exemplified by a seal impression found within house E13.7 (20th Dynsty) exactly matching a scarab accompanying a young adult female in contemporary chamber tomb G234 in Cemetery C (see Figure 3.12). Even though it is an intriguing thought, proving that the seal was made by this particular scarab remains impossible.

Figure 3.12 Seal impression F7250 with scarab F9167

With regard to spatial and chronological distribution, scarabs were almost exclusively found in chamber tombs, and only one example of a scaraboid (F9312) was recovered in a niche burial (G220). Scarabs are generally more common in the New Kingdom tombs (69.2%, 18/26 examples) than in the post-New Kingdom tombs (42.3%, 11/26 examples). This difference is even more evident when taking into account the fact that the number of post-New Kingdom individuals by far exceeds the number of New Kingdom burials. The majority of scarabs were found associated with an individual, and in all but one example they were placed in the hands of the individual. Only Sk244-10 had a scarab near the feet.

Inscriptions on the reverse of the scarabs are varied. Most commonly, they depict different combinations of signs and symbols associated with Egyptian religious belief systems including the sun disc, maat feather or ureaus. Royal names are also attested, most commonly the name of the cartouche of Thutmosis III, *Men-kheper-ra* (see Figure III. 23: F9164, Figure III.41: F9024,: Figure III.46: F9497, F9499, Figure III.50: F9100). This corresponds to observations throughout Nubia in sites dating to the New Kingdom (Säve-Söderbergh & Troy, 1991a: 94) but also post-New Kingdom and Napatan periods (Vila, 1980, Lohwasser, 2008: 256), paralleling the trend in Egypt proper (Jäger, 1982). The importance of Thutmosis III in Nubia is also reflected in the fact that he was venerated as a deity, manifested in temples at Debeira and el-Lessiya (Kemp, 1978) but also as part of household cult as evidenced through a re-used door lintel in house E13.6 at Amara West (Spencer, 2014c). Two scarabs bear the name of Ramesses II (see Figure III.30: F8023 Figure III.37: F8365). In addition, there is one scarab with the cartouche of Amenhotep II (F8205, see Figure III.55) and Amenhotep III (F9738) respectively. Similar to Thutmosis III, the reigns of both pharaohs well precede the time of occupation of Amara West and it therefore appears likely that these elements represent re-used objects or heirlooms rather than bearing any chronological significance. Representations of gods are relatively rare with only two examples. Decorations on most scarabs conform to standard Egyptian styles and find close parallels in cemeteries in Egypt proper too. Three types of materials were used for scarabs: steatite, often glazed in blue or green (New Kingdom: 11; post-New Kingdom: 6), faience (New Kingdom: 1, post-New Kingdom: 5) and ivory (New Kingdom: 3, post-New Kingdom: 0). While faience and steatite by far comprise the majority of Egyptian scarabs, the use of ivory is only very rarely seen and may again attest to local Nubian influences. One such example was found at Sanam out of over 500 scarabs (Lohwasser, 2010: 158). Heart scarabs, representing one of the most important funerary amulets in elite Egyptian funerary ritual from the Middle Kingdom onwards (Taylor, 2001: 206), were not recovered at Amara West. However, it has to be noted that the burials in the pyramid tombs even though generally intact, do display signs of disturbance in the neck/breast area which attests to targeted looting in the area where heart scarabs would have been expected.

Amulets depicting different goddesses and gods are another common category of equipment in Egyptian funerary ritual and had the purpose of placing the wearer under the protection of the particular deity (Taylor, 2001: 205). Only a small number of amulets evoking Egyptian deities have been recovered at Amara West. Most notably, all of them are from post-New Kingdom contexts, and seven were found in chamber tombs and three in niche burials. The most popular gods were Bes, Hathor and Isis (two examples each, see Figure III.41: F9058, Figure III.60: F9453; Figure III.50: F9060, F9063, Figure III.41: F9041, Figure III.60: F9466) followed by Pataikos (one example, see Figure III.60, F9467). In Egyptian contexts, the most common deities are Isis and Nepthys (Taylor, 2001: 205) even though there is generally a lot of variation. Pendants and amulets evoking Egyptian deities were popular in Nubian cemeteries of Egyptian cultural affiliation too, and the spectrum of goddesses and gods present at Amara West finds close parallels elsewhere in Nubia. The continued use of Egyptian religious amulets during the post-New Kingdom period is equally well evidenced in sites such as Hillat el-Arab (Casali, 2006), Missiminia (Vila, 1980) or Sanam (Griffith, 1923).

While most of the faience amulets conform to the conventional Egyptian style, the ivory Bes amulet (F9453, see Figure III.60) recovered from a post-New Kingdom niche burial (G216) is very unusual. Even though the body displays the usual attributes of a Bes figure, the head represents a significant departure from the traditional Egyptian style and presumably reflects local Nubian stylistic elements. Up to present knowledge only one parallel is known. It is held in a private Swiss collection and supposedly originates from Helwan, but was wrongly dated to the Predynastic Period (Chappaz, 1981: 84, 93/Fig. 049). In addition to the horizontal drilling in the head, confirming its original purpose as a pendant, the body displays two more holes in his chest. These are rather crudely drilled and seem to have been applied secondarily, possibly attesting to a change in function. A similar modification was observed in the carnelian Bes amulet recovered by the EES (Spencer, 2002: Pl. 8: 330). These alterations tie in with the general question as to whether or to what extent the presence of Egyptian religious symbols indicates adherence to the belief system with which these items were originally associated.

Other forms of amulets such as *udjat* eyes, *djet* pillars or poppy amulets are also very common in contemporary Egypt (El-Sawi, 1979, Hulková, 2013). They are also seen, albeit to a lesser degree, in Nubian cemeteries of both New Kingdom (Säve-Söderbergh & Troy, 1991a: 129, Williams, 1992: 119) and post-New Kingdom date (Casali, 2006), but are very rare at Amara West (see Figure III.53) even though again it remains unclear whether this is due to looting.

3.9.5.ii (b) Shabtis

Another important item of Egyptian funerary rituals are shabtis, small anthropomorphic figurines with the purpose of serving the deceased in the afterlife or acting as its substitute (Taylor, 2001: 112). During the New Kingdom period, they are standard element of funerary ritual for individuals of all social classes, even though the number varies considerably according to status, ranging from several dozen in royal burials to only one or two in burials of non-royal background (Taylor, 2001: 124-–—126). A wide range of materials and colours was used for shabtis during the New Kingdom period, including faience, pottery and stone (Taylor, 2001: 126) and they would have often been inscribed with a magical spell (Taylor, 2001: 121). At Amara West, only one example of a shabti (F8004, see Figure III.31), made from fired clay, was recovered from the shaft of G301, a 19th Dynasty tomb in Cemetery C. However, as the object was recovered from the shaft, its association with an individual or chamber remains unclear, and the possibility of the object being re-used cannot be excluded. Its shape can be considered very unusual as it lacks typical New Kingdom attributes such as the wig, but in contrast displays very distinctive ears. Whether this deviation from the standard Egyptian form represents a reflection of local imitation remains questionable but may well be within reason. In Nubian cemeteries of the New Kingdom period, the frequency of shabtis is generally varied. While larger numbers were recovered at Sai, Soleb or Aniba, in cemeteries without pyramid superstructures, such as Fadrus or Qustul but also at Tombos, only a very small number was found. However, at both Tombos (Smith, 2003: 149) and Fadrus (1992: 92) the only surviving shabtis were made from wood and both authors acknowledge that the number of shabtis may have been significantly higher. In the rock-cut tombs at Amara West those would have likely not survived. In addition, the fact that the only shabti at Amara West comes from the shaft area, most likely not its original position, attests to the interest of looters in objects of this type. Therefore, looting stands again as an alternative explanation for the absence of shabtis at Amara West.

3.9.5.iii. Objects of everyday life

3.9.5.iii (a) Jewellery

Aside from pottery, objects of "daily life" were generally relatively rare at Amara West even though this category appears to be particularly biased due to looting. Somewhat more common were different jewellery items including large numbers of beads (mainly faience, ostrich egg shell and stone) and smaller quantities of bracelets (see Figure III.59: F9014, Figure III.60: F9463) and ear-/hair-rings (see Figure III.41: F9161, F9163; Figure III.32: F8443, F8444; Figure III.41: F9037, F9038, F9056; Figure III.23: F9014: F8050). In general, the spectrum of jewellery corresponds well with those found at other New Kingdom sites in Nubia (Schiff Giorgini, 1971, Säve-Söderbergh & Troy, 1991a, Williams, 1992, Smith, 2003, Casali, 2006, Minault-Gout & Thill, 2013) and Egypt (Brunton & Engelbach, 1927, Smith, 2003, Hulková, 2013). Pen-annular ear- or hair-rings with flat or serrated edges made from red jasper and carnelian were found in four New Kingdom (15 examples) and one post-New Kingdom chamber tomb (three examples). Earrings of this type are a popular item in the New Kingdom throughout Egypt (Andrews, 1990: 115–116) and Nubia (e.g. Minault & Thill, 1974, Williams, 1992: 102–103, Smith, 2003: 152, Fig. 6.18). Williams argued that serrated edges indicate a Nubian cultural background while flat edges are a manifestation of Egyptian ties. At Amara West, both types are equally common even though it seems notable that ear-rings with edges were only recovered associated from the New Kingdom pyramid tombs (G301 and G309). Rings with serrated edges were most common in the G244, but also occur in New Kingdom and post-New Kingdom chamber tombs in Cemetery C.

The most common form of jewellery were beads, even though in most cases those could only be recovered from disturbed fill contexts than in situ. Several chronological and spatial patterns may be noted even though again this is likely biased due to looting. While faience represented the preferred material used for beads during the New Kingdom period, in the post-New Kingdom period, the most common type were ostrich egg shell disc beads, even though faience remains to be popular. Beads made from ostrich egg shell are very popular in Nubian tombs of C-group and Kerma affiliation (Williams, 1983). In Egypt proper, the use of this material is by far less common (Phillips, 2000), a fact that may simply reflect lack of availability rather than a deliberate cultural preference. Other materials used for bead production were carnelian, calcite and jasper, occurring throughout the time span of use even though they were by far less common. Beads from shells (*nerita,* see Figure III.60: F9464 and cowry, see Plate III.66: F9510) were only found in post-New Kingdom contexts. Nerita shells are common items of the Lower Nubian C-Group and Pan Grave cultures (Williams, 1983: 113) and may therefore be regarded as an indigenous cultural element.

In the niche burials, the amount of jewellery decreases further, even though this may well be related to the high degree of looting as almost no niche burial was undisturbed. Pen-annular ear-rings were entirely absent. Aside from beads, the only jewellery items recovered were bracelets in copper alloy and Egyptian blue (one example each, see Figure III.59: F9014, III.60: F9463). Another notable difference between chamber and niche burials is the predominance of ostrich egg shell disc beads over other types of materials in the latter. In the chamber tombs, faience beads appear by far more common.

3.9.5.iii (b) Toiletry articles

Toiletry articles are also very rare and almost exclusively confined to examples from chamber tombs (see Figure III.41). For the New Kingdom period, this comprises a copper alloy mirror (G309-W, see Figure III.32: F8448) and a copper alloy razor or knife (G301-E). In addition, several items including an ivory comb and a perfume/ointment jar made from faience were recovered from chamber 244.1 in G244. In the post-New Kingdom chamber tombs the assemblage of toiletry articles is somewhat larger, including a cosmetic container made from wood and an intact wooden cosmetics applicator as well as two pairs of tweezers (see Figure III.50: F9206; Figure III..41: F9053). In niche burials, the only, as yet tentative evidence for the continued use of toiletry articles as grave goods comes from G240. Fragments of a tubular object with traces of red, blue and yellow pigment may represent the remnants of a cosmetic container (see Figure III.68: F9519). However, due to preservation and looting, many of those items may have simply not survived and the archaeological record may therefore not necessarily be representative.

3.9.5.iii (c) Head-rests

Wooden head-rests represented another relatively common item in chamber tombs of New Kingdom and post-New Kingdom date (see Figure III.44: F9064, F9666). Their symbolic significance in funerary contexts is likely connected with the notion of death as sleep (Taylor, 2001: 108). A similar conception within the Nubian belief system is likely reflected in the common usage of burial beds in tombs. According to Taylor (2001: 108), aside from royal tombs dating to the Old and Middle Kingdom, head-rests were not that common in Egyptian cemeteries. However, Smith (1992) reported head-rests being a frequent item in Theban tombs of the 17th and 18th Dynasty. A small number of New Kingdom examples were also found in high status 18th Dynasty graves at Deir el-Medineh (Bruyère, 1937: 46–47, Fig. 20) but also at Abydos (Peet & Loat, 1913: 29–34). In Lower Nubian cemeteries, a few examples were reported at Qustul (Williams, 1992: 92–93) and Aniba (Steindorff, 1935: 123). At Amara West, five head-rests were found in New Kingdom graves and 12 in post-New Kingdom graves, even though the true number is likely to be much higher due to poor preservation. They were by far more common in Cemetery C, but only one example has been found in Cemetery D so far (G319, New Kingdom), even though again this is likely unrepresentative. Even though not uncommon in high status tombs in Egypt proper, the frequency of head rests at Amara West nevertheless appears unparalleled. It may therefore be suggested that this preference is also a reflection of Nubian funerary beliefs. Continuing the tradition of equating death with sleep, they at least temporarily replaced burial beds as the central symbolic manifestation of this notion. However, due to the possibility of differential preservation, comparison of frequencies of organic objects between cemeteries has to be viewed with caution.

3.9.5.iv. Pottery

The most abundant category of grave goods in the cemeteries of Amara West was pottery (see Figure 3.13). In Egyptian funerary rituals vessels served as container for food which represented an essential part of provisions for the afterlife and therefore pottery rank amongst the most common type of grave goods in Egyptian funerary contexts (Taylor, 2001: 92). During the late New Kingdom, the deposition of pottery fell out of fashion in some areas of Egypt proper as a result of the general shift in funerary assemblage from objects of daily life towards specialised funerary equipment (Grajetzki, 2003: 90). However, this was not the case in other sites such as Amarna which attests to the fact that funerary rituals also followed some highly regionalised patterns (Grajetzki, 2003: 91). In New Kingdom Nubian sites, pottery remained the most common type of grave good (Smith, 2003, Vincentelli, 2006: 5). Within the Nubian cultural sphere, ceramic vessels are a similarly important feature

Figure 3.13 Vessels accompanying the burials in the western chamber of G309 (New Kingdom)

of funerary ritual throughout history (Geus, 1991). At Amara West, pottery equally represent the single most common type of grave good throughout the time period of use of the cemeteries, both in chamber tombs and niche burials. Detailed studies of the pottery where conducted by Millet (2009-2013) and by Kilroe (2013) within the framework of a master thesis at the Faculty of Oriental Studies at Oxford University. The following will only provide a brief summary of their findings.

In general, the ceramic assemblage present in the graves at Amara West is of almost entirely Egyptian character and of wheel-thrown make. Notable is the relatively limited variety of forms. During the New Kingdom period, assemblages compriss mainly plates or beer jars together with a smaller number of different jars and imports (see Figures III.24, III.25, III.29, III.36). The assemblage recovered from the tombs is closely paralleled in contemporary deposits in the settlement of Amara West and is also consistent with findings from other New Kingdom Nubian cemeteries. During the post-New Kingdom period a gradual shift occurs towards smaller and deeper bowls, mainly featuring a red rim or red burnish even though beer jars and plates are still abundant (see Figure III.38, III.40, III.47, III.49, III.53, III.54, III.56, III.57). In the niche burials, the traditional New Kingdom plates and beer jars are entirely absent (see Figure III.61, III.63, III.64, III.67, III.69). This trend is paralleled at other potential post-New Kingdom sites at nearby Missiminia (Vila, 1980) or Sanam (Griffith, 1923) where red-rimmed and red-burnished bowls comprise the majority of the pottery assemblage.

Another notable addition to the post-New Kingdom pottery assemblage are pilgrim flasks made from marl clay (see Figure III.38: C9000; III.52: C9007; III.54: C8019; III.56: C8049; III:63: C9017, III.67: C9153) which are so far entirely absent from New Kingdom contexts. A similar trend was also noted at Hillat el-Arab (Vincentelli, 2006) and Missiminia (Vila, 1980) but is unparalleled in Egypt proper. Millet suggests that the pilgrim flasks represent a local adaptation in the offering cult, replacing beer jars in holding libations (Millet, pers. comm. 2013). However, any such claims are impossible to prove. The percentage of pilgrim flasks at Amara West and other sites is very small when compared to the relative number of beer jars in the New Kingdom assemblage. Since marl clay deposits have not yet been identified in Nubia, it has to be assumed that they were imported from Egypt proper which would have given them significant value. Their presence in some graves may have simply reflected individual choice.

Pottery of Nubian fashion in contrast is almost entirely absent in burials at Amara West. The only complete example of a Nubian-style pot was recovered accompanying an infant buried in a niche tomb in Cemetery C (G204, see Figure III.54). This is again consistent with all comparative Nubian sites. The amount of Nubian-style pottery recovered from the settlement is also considerably smaller than the amount of Egyptian vessels and their purpose is almost exclusively confined to cooking pots (Spencer, 2014b). The almost complete absence of pottery of clear Nubian fashion from tombs is striking and raises interesting questions about the ideological value and significance assigned to the different cultural manifestations.

Inferences about the configuration of the vessel assemblage also have to take into consideration the use of baskets as an alternative type of container. Remnants of basketry were noted in several post-New Kingdom tombs such as G211 (see Figure III.50: F9686), G226 (see Figure III.62) and G314 (see Figure III.55: F8203). Pottery was very scarce in these tombs. It therefore remains possible that baskets fulfilled similar functions in funerary ritual and, depending on factors such as availability, individual choice or socio-economic status could replace pottery. Due to poor preservation, baskets could only be recovered in fragments, and therefore again we may only be getting a very incomplete picture of the full assemblage which further cautions against making too detailed cultural or chronological assumptions.

	New Kingdom chamber tombs	**Post-New Kingdom chamber tombs**	**Niche burials**
Funerary ritual			
Coffins	x	x	x
Funerary bed		x	x
Extended burials	x	x	x
Flexed burials		x	
Grave goods - specialised			
Shabti	x		
Amulets	x	x	x
Scarabs/scaraboids	x	x	x
Grave goods – "daily life"			
Penannular ear-rings	x	x	
Ivory jewelry	x	x	x
Toiletry articles	x	x	
Head-rests	x	x	
Beer jars	x	x	
Pilgrim flasks		x	x

Table 3.15 Distribution of main finds categories between different grave types

3.10. Chronology and development of the cemeteries

3.10.1. Cemetery C

As had already been proposed by Vila, the earliest tombs documented in Cemetery C were constructed in the Ramesside period (Vila, 1977b: 28–31). The earliest grave documented in Cemetery C so far is G244, the multi-chamber tumulus. Pottery sets the tomb firmly into the 20th Dynasty with some close parallels coming from the tomb of Ramesses IV (Millet, pers. comm. 2013). The simple chamber tomb G234 also features a pottery assemblage (five plates and eight beer jars) well known from late New Kingdom sites, even though Aston observed that it is difficult to distinguish beer jars between the Late New Kingdom and Libyan layers at Elephantine (Aston, 1999: 72). Nevertheless, the vessels present in G234 find very close parallels in the deposits of the town site, most notable from well dated late Ramesside layers in an extramural villa (Millet, pers. comm. 2011). This dating is further consistent with the known chronological frame for the use of multi-chambered tombs in general (Williams, 1992: 3).

The ceramic material in the remainder of the graves – both chamber and niche burials – excavated in Cemetery C post-dates the New Kingdom occupation (Binder, 2011). The most common vessel types occuring in Cemetery C are shallow bowls with thick red-painted rims which were found in niche graves with (G239) and without (G210, G216) tumuli, as well as in two chamber tombs (G200, G201). Similar examples were found in Egypt and are dated to the 11th–10th centuries BC (Aston & Jeffreys, 2007: 42). In Nubia, the same type of bowls were common in niche graves in the necropolis of Missiminia, near Amara West on the east bank of the Nile. Even though they were originally dated to the Napatan period (Type I–1, Vila, 1980: 55–56, fig. 167) they might in fact be earlier. In addition, the ceramic assemblage of G201 also held a number of beer jars and plates similar to those recovered from G234. However, even though those forms echo typical late New Kingdom shapes, they already seem to represent a departure from the Egyptian originals possibly indicating local imitations (Binder, 2011). Similar tendencies were observed in the cemetery of Hillat el-Arab near the 3rd Cataract which closely corresponds with Amara West in terms of ceramic assemblage, material cultural and grave architecture (Vincentelli, 2006: 2). Petrographic analysis carried out on sherds recovered from the town in 2009 provides further support for a local origin of Egyptian style vessels found at Amara West (Spataro, pers. comm., 2010). Further notable is the introduction of pilgrim flasks to the ceramic assemblage of graves of the post-New Kingdom period.

The niche burials were introduced at Amara West only during the later period of use (Binder, 2011). In terms of ceramics assemblages, they are lacking the typical late New Kingdom forms such as plates and beer jars. In contrast, forms such as red-burnished slip bowls only occur in the niche burials but are absent from the chamber tombs. Whereas niche burials are known from New Kingdom cemeteries of Lower Nubia such as Qustul (Williams, 1992), in Upper Nubia they are so far only known from the post-New Kingdom period onwards, with examples at Sai (Geus *et al.*, 1995), Missiminia (Vila, 1980), Tombos (Smith, 2007) and Sanam (Griffith, 1923, Lohwasser, 2010). At El Kurru where the tombs of the earliest rulers are tumuli with niche substructures (Dunham, 1950). Due to general difficulties in dating post-New Kingdom pottery, niche burials in the other Upper Nubian sites are all dated to the Napatan period. However, with new excavation results and re-appraisal of ceramic assemblages, at least some of the niche burials at Sanam, Missiminia and Tombos may in fact also date to the 10th–9th centuries rather than the Napatan period (Millet, Smith, pers. comm). At Amara West, this date is further supported by a C^{14}-date on bone bioapatite obtained from a niche burial (G237) dating the burial between cal BC 1030–890[1] (Meadows *et al.*, 2012). Distinctive, fully developed Napatan shapes such as marl clay storage jars (Aston, 1999: pl. 56, 1698) are entirely absent from Amara West, which provides further support for a dating of Cemetery C to no later than then mid-8th century BC. Thus, in conclusion, the ceramics so far recovered from Cemetery C indicate a long time span of use ranging from the 13th until the 8th century BC.

3.10.2. Cemetery D

The earliest secure date for Cemetery D obtained so far comes from the western chamber of G301. The pottery assemblage features forms popular throughout the New Kingdom such as the beer jars and plates. However, the marl D wine-jar (see Figure III29, C8009) narrows the dating to the Ramesside period (Aston, 1996: 305, fig. 203c). The palaeography of its inscription further indicates a dating to the reign of Ramesses II (Demaree, pers. comm, 2010). This is supported by a scarab bearing the prenomen of Ramesses II recovered from the western burial chamber (F8023, see Figure III.30). This dating could recently be confirmed through radiocarbon-dates obtained from bone

[1] KIA-46314 237 bioapatite 2807±26 1030–890 cal BC

bioapatite of the two individuals buried in the western chamber of G301[2] (Meadows *et al.*, 2012). The other pyramid tombs, G112 and G309, also contained pottery dating to the Ramesside period even though use of both graves dates to the 20th Dynasty (Spencer, 2002; Millet, pers. comm, 2012). The style of the painting on the coffin mask on G309 also correlates well with examples from Egypt dating to the 20th Dynasty even though this conclusion may potentially be misleading since styles may take some time to travel and conservatism in funerary traditions may have been more marked in Egyptian Nubia. The architectural type of the graves is also consistent with a New Kingdom date. Tombs of similar architectural layout are also found in cemeteries in other major New Kingdom Egyptian towns in Nubia, notably at Sai (Minault-Gout & Thill, 2013), Soleb (Schiff Giorgini, 1971), Tombos (Smith, 2003) and Aniba in Lower Nubia (Steindorff, 1937), and also find close parallels throughout Egypt proper such as at Deir el-Medina (Bruyère, 1924) or Gurob (Brunton & Engelbach, 1927). The tombs at Amara West only differ from their counterparts in size, as the ones found at other sites are mostly considerably bigger. On the one hand, chronological reasons could account for this difference as they date to the 19th Dynasty in contrast to above mentioned sites which were in use during in the 18th Dynasty. However, it has to be kept in mind that only a part of the cemetery has been excavated so far. The pyramid tombs at Sai are similarly variable in size with the smallest examples corresponding in size to the ones at Amara West. A geophysical survey carried out early in 2014 indicates the presence of at least one larger mudbrick superstructure in the eastern part of Cemetery D. Even though the date of this larger structure is yet unknown it seems possible there are reasons other than chronology underlying the differences in size. Aside from the pyramid tombs only one more single-chambered tomb G319 could be dated to the New Kingdom period. Lacking any traces of a superstructure, it may attest to the fact that Cemetery D was not exclusively reserved for elite burials.

In addition, all New Kingdom tombs show evidence for extensive post-New Kingdom re-use, as was already suspected during the EES excavations (Spencer, 2002: 2). In G301 and G309, ceramics dating to the post-New Kingdom are abundant and confined to the shaft and smaller burial chambers off its east and north-east side. This raises the possibility that both graves originally only feature a burial chamber on the western side which is consistent with traditional Egyptian architectural models, while the burials on the eastern side represent secondary additions during the post-New Kingdom

[2] KIA-46312 301-3 bioapatite 2944±26 1260–1050 cal BC, p=95
KIA-46313 301-4 bioapatite 2908±24 1210–1015 cal BC, p=95

period. It is also notable that in both cases the eastern/north-eastern chambers are considerably smaller, irregularly shaped and less-well prepared which further support the idea that those chambers represent later additions. The internal stratigraphy of the third pyramid tomb G112 remains unclear due to the lack of documentation during the EES excavations.

The vaulted tomb G101 is situated on the same alignment in between the two pyramid tombs which may suggest contemporanity. Dating of the tomb excavated by the EES is difficult due to lack of recording and therefore related stratigraphic information for the finds. Only two vessels may date to the New Kingdom period, the remainder of the vessels is clearly of post-New Kingdom date. The ceramics assemblage comprises shallow bowls with thick painted red rims closely resembling those found in Cemetery C, but also others bearing close similarities to the cemetery of Missiminia. Thus, it seems reasonable to assume that G101 was built later, perhaps contemporary to the phases of re-use of the New Kingdom tombs.

G305, featuring a vaulted shaft and a tumulus superstructure, as well as the other tumuli G300, G304 and G314, can equally be dated to later phases of use of the cemetery. The forms present in those tombs indicate that they were already constructed during the post-New Kingdom period. In addition, two single (G315, G317) and one double-chamber tomb (G316) appear to be contemporary. In summary, the tombs excavated in Cemetery D of Amara West so far attest to a continued use over a long time period ranging from the 19th Dynasty to the early Napatan period. While old graves were re-occupied, new graves continued to be constructed during the entire time period. However, it remains unclear, whether this indicates a continuous process or whether we are dealing with two temporally distinctive phases of use, but it is likely that this will be clarified through future field work.

3.11. The niche burials in Cemetery C – Cultural change or population replacement?

3.11.1. Evidence from funerary culture

The exact relationship between the two grave types has yet to be clarified and it remains unclear whether they reflect a gradual transition within an otherwise stable population or whether the cultural transition went alongside population replacement. This uncertainty is partially due to the insufficiently high resolution of dating methods available in archaeology. The ceramic assemblage does not indicate a clear break as there is considerable overlap with similar forms such as the shallow bowls with red-rims being present in both grave types.

Grave G211 represents a composite grave featuring both a burial chamber and two burial niches, even though it seems possible that the grave represents a reflection of a transition between two distinct burial traditions but other underlying factors accounting for this hybrid grave type. A comparable example was found at Qustul (VF 72 A, Williams, 1990: 75, 77, Fig. 27, VF 72 BA, Williams, 1992: 311–317, Fig. 134–137) which featured an eastern and north-eastern burial chamber dated to the New Kingdom period, but also a northern burial niche interpreted as Napatan re-use of a New Kingdom tomb.

3.11.2. Biomolecular evidence

Strontium and oxygen isotope analysis of bone and teeth are now an established tool to track the mobility of past human populations and could shed further light on the transition between chamber and niche burials from a biomolecular perspective (Katzenberg, 2008, and see Chapter 5). The isotopic composition of skeletal tissue reflects the local isotope signature at the time when teeth (first 10–12 years of life) or bone (last 10 years of life) where forming. Teeth of eight individuals from niche burials and 16 individuals from chamber tombs were analysed by Buzon at Purdue University for strontium isotope ratios. Oxygen isotope data was obtained for seven niche burials and 21 individuals from chamber tombs by the author (see Section 8.13.2). Neither strontium nor oxygen isotopes provide any indication of non-local people buried in the niche burials (Buzon, unpublished data and see Section 9.12.2.ii). A Mann-Whitney U-test did not produce any statistically significant differences between the two groups (δ^{87}Sr: $p=0.811$, δ^{18}O: $p=0.540$).

3.12. Egyptian–Nubian interactions – Implications of the funerary evidence

Treatment of the dead represents one of the central manifestations of human cultural behaviour. Consequently, graves and cemeteries have always been one of the most important sources of data for the study of past human populations (Tarlow & Nilsson Stutz, 2013a). In archaeological research material culture from funerary contexts, grave architecture, and evidence for the treatment and orientation of the body have been used to characterise cultures, infer ethnicity, social complexity, migration, gender or belief systems in the past. However, funerary archaeology and the validity of inferences about past human culture also represents one of the most debated areas of anthropological and archaeological research, attested by a large body of theoretical literature (e.g. Brown, 1971, Metcalf & Huntington, 1991, Parker Pearson, 1999, Rakita *et al.*, 2005, Tarlow & Nilsson Stutz, 2013b). Central to the problem is the fact that the funerary record is a reflection of a ritualised rather than a real world (Hodder, 1982: 163). The way in which a person is buried is governed by those burying and not necessarily the individual him- or herself (Parker Pearson, 1999: 3). Consequently, any inferences about social structure or cultural affiliations based on evidence from funerary contexts need to be viewed with caution.

Archaeological research into Nubian history represents no exception in its reliance on cemetery data. The strong dichotomy between Nubian and Egyptian funerary customs provides a well suited basis for any such studies and has therefore been one of the most important and widely used source of data for any discussion of the complex relationships between the two neighbouring territories in the past (see Section 2.3.3). The time period of the New Kingdom occupation of Nubia is marked by an almost complete disappearance of local Nubian cultural elements (see Section 2.3.3.i). However, despite the distinctive archaeological record, the modes underlying this apparent transformation, the configuration and social structure of the colonial communities in occupied Nubia remains far from being understood (Edwards, 2004: 111, Van Pelt, 2013). Even though the theory of large-scale immigration of Egyptians to Nubia and consecutive population replacement accounting for the rapid and apparently thorough Egyptianisation of Nubia has long been discarded, in the absence of Nubian written sources the fate of the Nubian population still remains unclear and continues to be the subject of scholarly debate (Van Pelt, 2013).

The cemeteries of Amara West represent a well-suited case study, allowing for new insights into the relationships between the local Nubian population and the Egyptian colonial administration as well as the cultural processes accompanying Egyptian occupation of Nubia during the New Kingdom period. As has been outlined in the foregoing section, funerary practices employed at Amara West represent a complex, highly variable mosaic of both Egyptian and Nubian cultural elements throughout the time span of use of the cemeteries even though the Egyptian aspect prevails by far. This is consistent with the archaeological evidence from the settlement at Amara West which is equally dominated by Egyptian cultural features (Spencer, 2014a, b). During the time when Amara West served its function as an administrative centre, it would have housed a number of officials serving within the ranks of the colonial administration. The presence of sizable houses such as the "Deputy's residence" (E13.2) identified by the EES as the residence of a series of individuals holding the title of "deputy of Kush" through inscribed door lintels and jambs within the building (Spencer, 1997, 164, 168–9, pls 117a–b, 121a–b, 153b, 166a–b), or the Egyptian-style villas west of the town wall (Spencer, 2009) clearly attest to a number of high status individuals residing at Amara West. However, it is as yet impossible to determine whether these would have been Egyptians transferred to Nubia or local Nubians. Moreover, the nature of the housing in the town is consistent with contemporary sites across Egypt (Spencer, 2014a). Thus, even though the presence of a small number of Egyptian colonial officials or military personnel in the Nubian settlements seems likely based on textual evidence at least in the initial phases of occupation, it should be assumed that Nubians were amongst the inhabitants. In addition, it has to be taken into account that Amara West was founded *c.* 1300BC, 200 years after the Egyptian conquest of Nubia. By this time, settlements in both Upper and Lower Nubia had already undergone complete Egyptianisation and traces of local Nubian culture had almost completely disappeared. The people settling at Amara West may have well come from other Egyptian settlements in the vicinity such as Sai or Soleb, thus even though being local Nubian people in a geographic sense, a fact supported by stable isotope analysis (see Section 2.3.3.vi), they would have derived from highly Egyptianised cultural contexts. Only a small number of sites attests to the survival of Nubian culture into the New Kingdom both in Upper Nubia (Welsby, 2001, 589–591) and in Lower Nubia (Säve-Söderbergh, 1989, 23–24). However, this picture may well be explained by a significant research bias created by a predominance of interest in Egyptian sites, but also preservation issues that preclude the survival of organic materials. Therefore, much more field work would be needed in order to allow for any more conclusive statements about the survival of more traditional Nubian communities alongside the Egyptian colonial settlements.

A more in-depth examination of the funerary evidence at Amara West reveals certain patterns within the funerary evidence which, even though superficially resembling Egyptian models, also somewhat deviate from the traditional Egyptian norms. As has been outlined in section 3.9.5, items essential in Egyptian funerary ritual such as shabtis, heart scarabs, amulets, papyrus *Book of the Dead*, and full mummification including extraction and mummification of internal organs and their placement in separate Canopic jars, are almost entirely absent from Amara West. Similar patterns can be observed at Tombos, Fadrus or Qustul. Based on their assessment of the cemetery at Fadrus, Säve-Söderbergh & Troy (1991a: 248) were the first to argue that this lack of specialised funerary equipment indicates only superficial acculturation and adoption of Egyptian belief systems. However, this was criticised by Smith (2003: 157), who attributed the lack of specialised grave goods to a low social status of the burials at Fadrus. He based his argument on comparison with other contemporary non-royal cemeteries in Egypt proper (Harageh, Qau and Gurob) where specialised objects such as shabtis, heart scarabs or canopic jars were also rare but present nevertheless. Even in the low status Ramesside cemetery at Tell el-Dab'a the graves were equipped with a considerable number of shabtis (Hulková, 2013: 92). The complete absence of specialised funerary items at Amara West from elite and non-elite contexts is therefore striking. Even though this has to be viewed with caution in light of extensive looting, even in relatively intact contexts such as the elite burials in the western chamber of G301 no such items were found, despite the fact that other objects such as an intricate scarab and bronze knife escaped looting. Notably absent are other features also related to traditional Egyptian funerary ritual such as offering tables and funerary stelae. Säve-Söderbergh and Troy (1991a, 8–9) further utilized the lack of inscribed names in the graves of the colonial cemetery at Fadrus as an indicator of superficial 'Egyptianisation', because the presence of names is also central to Egyptian funerary beliefs. Similarly, no names have been found in the graves at Amara West, but few of the object types which would have borne such inscriptions have been found. Furthermore due to the poor state of the coffins any such inscriptions would not have been preserved.

This ties in with the question of whether and to what extent the mere presence of objects related to Egyptian religious beliefs in the graves indicates that people adhered to these beliefs. The ivory Bes amulet, besides displaying a mixture of Egyptian and Nubian stylistic elements, also attests to a change of function. While it was originally crafted to be worn as a pendant, the four carelessly drilled holes indicate that at some point it was used in a different way. A similar example was recovered by the EES from G112 in Cemetery D. The carnelian Bes amulet (330) displays four secondarily applied holes in its body (Spencer, 2002, 7, Pl. 8:330). However, whether this change of function also implies a change of religious significance remains open to speculation.

Traditional Nubian burial customs, exemplified through tumulus superstructures or burial beds (Geus, 1991) are by far less common, particularly during the New Kingdom period. The only clear example dating to the New Kingdom period is the chamber tomb G244, with its tumulus superstructure which would have been a very prominent feature in the landscape, represents a unique blend of the two cultures. Even though the tomb owners chose some important attributes of Egyptian funerary culture, other items present in the graves such as the ivory jewellery, ostrich egg vessels but also the presence of fully equipped child burials within the grave indicate substantial Nubian influences. In addition, the presence of Nubian pottery in the New Kingdom settlement strongly cautions against cultural inferences based on cemetery data alone because it is highly biased towards highly ritualised objects and symbols. Even though occurring in exclusively utilitarian context, their presence attests to the survival of traditional Nubian practices.

In tombs dating to the post-New Kingdom period, Nubian cultural elements become more visible again, attested through the use of funerary beds and an increased number of tumuli. The funerary culture appears more varied, with Nubian and Egyptian burial custom being used alongside each other often in the same tomb, than during the foregoing period. However this may potentially be biased by the smaller number of New Kingdom graves excavated so far. A "re-emergence" of local customs after Egyptian control waned can also be traced elsewhere in Nubia (Geus, 1991). Even though the underlying modes and patterns remain far from being understood due to the highly fragmentary archaeological record of this time period, graves at Amara West and elsewhere in Nubia indicate a deliberate re-integration of traditional Nubian funerary customs. Nevertheless the Egyptian cultural element retains its predominance, even though this seems hardly surprising because 400 years after the Egyptian conquest these elements would have likely been so deeply embedded into they could be seen as local too. Cemeteries dating to the post-New Kingdom and Napatan periods reflect a highly variable hybrid culture with both Nubian and Egyptian cultural elements being used alongside each other. The increase in use of Nubian cultural elements in the cemeteries may attest to a newly assigned value and significance of ancestral patterns that expressed adherence to a Nubian cultural heritage.

In conclusion, the funerary record, architecture, treatment of the body and the configuration of the assemblage of grave goods at Amara West suggest a deliberate choice of some attributes and objects such as coffins and scarabs over others, resulting in a new local tradition. Style and decoration of the coffins, handmade imitations of Egyptian-style vessels (see (see Figure III.54: C8014, C8021), or the decorations of some scarabs, all indicate local adaptations of Egyptian forms. These findings reflect an active and dynamic process of hybridisation rather than passive acceptance of a foreign culture, as indicated in earlier theories of acculturation.

Chapters 2 and 3 set the historic and archaeological stage for the research questions addressed in this thesis. The following chapters 4 and 5 will provide information on the theoretical, clinical and epidemiological background of the indicators and methods used to analyse health and living conditions at ancient Amara West.

Chapter 4. The study of health and disease in past human populations

4.1. What is health?

Before discussing health in past human populations it is necessary to first consider how health can be defined. Generally, health as a concept is problematic because it is a very culture-specific phenomenon (Bush, 1991). Perceptions of health vary considerably depending on whether it is defined from a medical, cultural or biological perspective. Cultural perceptions of health are generally difficult to determine for past human populations, particularly in the absence of textual evidence.

This reduces most attempts to study health in the past based on archaeological human remains to a purely medical approach to health. A large number of different definitions for the term "health" are available in current literature. By far the most commonly cited one derives from the preamble to the constitution of the World Health Organisation (WHO) in which health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1946: 2). However, this definition has been widely criticised as being unrealistic, especially with regard to the usage of the word "complete" which basically implies that health is something that will be very hard to achieve (e.g Saracci, 1997, Huber *et al.*, 2011).

In Dubos' (1965: xvii) definition "States of health or disease are the expressions of the success or failure experienced by the organism in its efforts to respond adaptively to environmental challenges". This ecological approach to health is widely used in bioarchaeological studies (Goodman *et al.*, 1988, Goodman, 1991, Larsen, 1997). Crucially, this definition underscores the fact that health is a dynamic process rather than static as is implied in the definition given by the WHO. One of the major shortcomings of this approach however is the fact that it ignores the contribution of psychological well-being on health and may therefore provide a misleading picture of health (Bush, 1991, Waldron, 2009: 10). A more comprehensive definition is given by J. Ralph Audy (1971: 142), who states "Health is a continuing property that can be measured by the individual's ability to rally from a wide range and considerable amplitude of insults, the insults being chemical, physical, infectious, psychological, and social". By underscoring the dynamic nature of "health", this definition also accounts for psychological and social factors contributing to health or lack of it.

4.2. Studying health and disease in past human populations

4.2.1. Introduction

Health and disease in past human population can be studied based on the occurrence of pathological changes in skeletal and mummified human remains (e.g. Larsen, 1997, Ortner, 2003, Roberts & Manchester, 2005, Ortner, 2011). This area of bioarchaeological research, also referred to as palaeopathology, has seen significant theoretical and methodological advances over the past century, moving away from outlining single cases of unusual pathologies to systematically analysing the occurrence of the pathological changes on a population basis (Ortner, 2011). In addition, the field has benefited from the integration and development of biomolecular techniques such as the study of stable isotopes or DNA, allowing further insights into disease processes in past human populations. While the preceeding chapters are integral to understanding the lives of the people who were buried at Amara West, the analysis of markers and patterns of diseases on their skeletal human remains represents the major focus of this thesis for reconstructing their health and living conditions. The basic theoretical and methodological concepts and limitations of palaeopathological research will be outlined in the following sections.

4.2.2. Theoretical and methodological limitations to the study of health and disease in past human populations

4.2.2.i. Representativeness of collections of human remains

A major issue arising for population-based studies of health in the past, based on archaeological human remains, lies in the representativeness of the skeletal samples available for studies (e.g. Ortner, 1991, Waldron, 1994, Roberts & Manchester, 2005: 12). Collections of skeletal human remains can be biased by a large number of factors (Waldron, 1994, Mays, 2010: 13–32). On a site specific level these include differential bone preservation, excavation methods and sampling strategies. In addition, cultural practices leading to differences in burial treatment can highly influence the composition of archaeological collections of human remains (Mays, 2010: 23). As a consequence, skeletal assemblages are not necessarily representative of their source population and this can potentially lead to misconceptions when inferring their health (e.g. Waldron, 1994).

4.2.2.ii. Skeletal responses to disease

One of the major problems of palaeopathological studies is inherent to bone physiology itself (Ortner, 2011). The skeleton only has very limited means to respond to a pathological insult: new bone formation, bone destruction and abnormality in size, density and shape (Ortner, 2003: 45). Depending on the disease, rapidity and duration of the pathological process, only one type or several different types of change can occur at the same time (Ortner, 2003: 45). Nevertheless the changes are often non-specific and many different conditions can lead to the same response (Ortner, 2003: 48). Attributing pathological lesions observed in human remains to a specific disease is often impossible based on macroscopic examination alone. Additional differential diagnostic evidence could be obtained through histological or biomolecular techniques such as aDNA analysis. However, the destructive nature limits the standard application of the technique in palaeopathological research (Roberts, 2013). Taphonomic changes can further mimic or obscure pathological lesions, limiting the potential of palaeopathological inferences in poorly preserved human remains (Ortner, 2003: 45–46).

Another major problem is associated with the speed in which skeletal bone responds to a pathological insult. The skeleton is usually the last organ to respond to a pathological condition (Bush & Zvelebil, 1991). Therefore, diseases only leave an imprint in bone when they reach a chronic stage (Ortner, 2003: 110). As a consequence, many diseases, particularly those of infectious origin such as typhoid, cholera, plague or dysentery, will not leave any visible imprints on bone and could only be detected in archaeological human remains through biomolecular techniques. In addition, skeletal response to a disease always implies long-term survival and a relatively effective immune response in the host. Therefore, the absence of pathological changes in the skeleton does not necessarily imply absence of disease, but could also result from a good immune response leading to recovery, or an ineffective immune response leading to death before skeletal changes occurred (Ortner, 2003: 110).

4.2.2.iii. The "Osteological paradox"

Three key issues potentially limiting any conclusions about health in the past drawn from human remains were outlined in the seminal paper published by Wood *et al.* (1992) and termed the "Osteological Paradox". These include: 1) nonstationarity of populations, 2) selective mortality within a population and 3) hidden heterogeneity in susceptibility to a disease. All of these factors are seemingly hard to control for in an archaeological context. The main implication of the paper was the proposition that healthy skeletons may not necessarily imply healthy individuals but rather that the individuals died before a skeletal response could be triggered (Wood *et al.*, 1992). Even though still far from being resolved, methodological and technological advances in bioarchaeology helping to refine information about demography and palaeopathological diagnosis, or corresponding socio-cultural factors, have significantly contributed to finding ways of addressing the problems outlined by Wood *et al.* (Wright & Yoder, 2003). The integration of multiple lines of palaeopathological evidence when inferring health as well as a thorough consideration of environmental and archaeological context, are further key elements that nevertheless allow researchers to gain valid insights into health in past human populations despite the theoretical and methodological limitations set by the nature of the evidence (e.g. Cohen *et al.*, 1994, Larsen, 1997: 6-7, Goodman & Martin, 2002)

4.2.3. The systemic stress perspective

Due to limitations in diagnosing specific diseases in human skeletal remains, systematic bioarchaeological studies of health in past human populations have adopted an approach in which health is inferred based on the occurrence of more generalised indicators of any physiological disruption due to an illness, malnutrition or other negative influences (e.g. Martin *et al.*, 1984, Larsen, 1997: 7, Goodman & Martin, 2002, Cohen & Crane-Kramer, 2007). These insults are summarised under the term "stress" and are defined as the result of a combination of environmental, social and cultural influences on the human organism (e.g. Huss-Ashmore *et al.*, 1982, Goodman *et al.*, 1988). The notion of stress applied in this model derives from the works by Selye who originally defined stress as a nonspecific hormonal reaction to a wide variety of noxious or stressful stimuli (e.g. Selye, 1936, 1957, 1973).

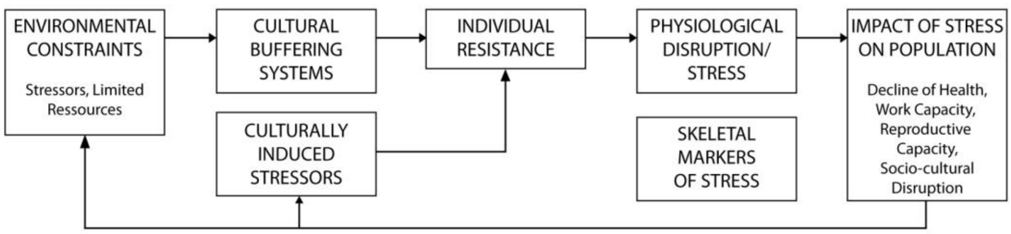

Figure 4.1 The "systemic stress perspective" model for interpretation of stress in archaeological populations (adapted after Goodman *et. al.*: 172)

This model, originating in a purely ecological approach to health, was originally developed by Huss-Ashmore and co-workers (1982) and is commonly referred to as the "systemic stress perspective" or biocultural adaptation model (e.g. Goodman *et al.*, 1984, Goodman *et al.*, 1988, Goodman & Martin, 2002, Zuckerman & Armelagos, 2011). According to this theoretical concept (see Figure 4.1), the quality of human adaptation, and consequently quality of life, is perceived as the result of the scale of impact of environmental, social and cultural influences on a population, and studied based on the appearance of a range of indicators of stress (for a more detailed discussion of stress markers see Section 4.3). Systematically analysing these indicators of stress and setting them against the environmental, social and cultural background of the population under study therefore allows for inferences about the status of health of an individual or population (Goodman *et al.*, 1988, Larsen, 1997: 6). Even though it has been criticised for failing to acknowledge the impact of psychological factors (Bush, 1991) this model is now commonly employed in population based studies of human health in the past (e.g. Cohen & Armelagos, 1984, Larsen, 1997: 6–8, Goodman & Martin, 2002, Cohen & Crane-Kramer, 2007).

4.2.3.i. The biocultural approach

As has been outlined in the foregoing, human health is governed by a complex set of interactions of behavioural, biological, social and natural processes. According to the principles of medical geography the state of health is enclosed by a triangle consisting of *population, behaviour* and *habitat* (Meade & Earickson, 2000: 15, see Figure 4.2). Despite the limitations to inferring health in past human populations due to shortcomings inherent to human physiology as well as the nature of the sources available for study (Wright & Yoder, 2003), other aspects of this triangle that

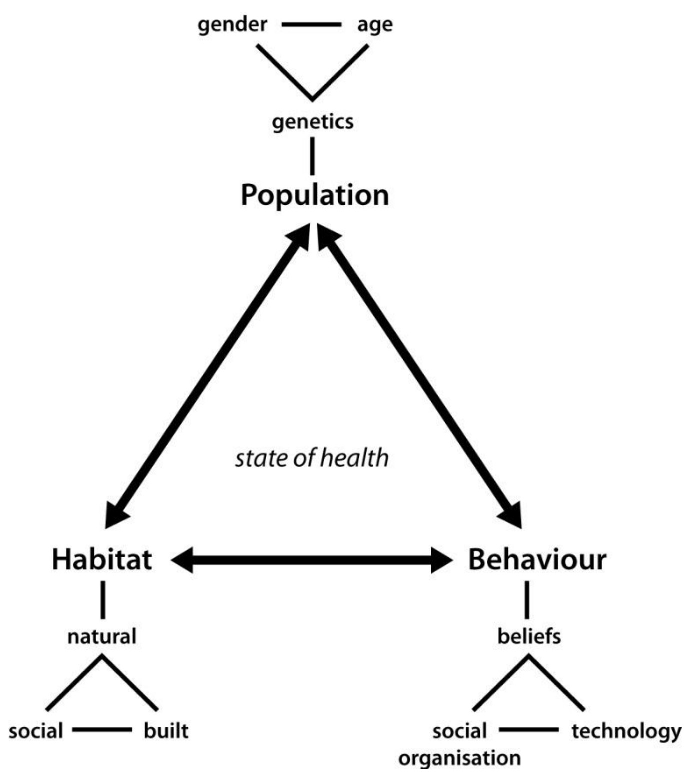

Figure 4.2 The triangle of human ecology (after Meade & Earickson, 2000: 25)

constitute human health may readily be identifiable through the help of archaeological, palaeoenvironmental, anthropological and historical research and are crucial to the understanding of health in past human populations. In bioarchaeological research this has been termed 'the biocultural approach' (e.g. Goodman *et al.*, 1988, Zuckerman & Armelagos, 2011). In studies following this paradigm, the underlying environmental, social and cultural dynamics and pressures acting upon a population, and consequently affecting human health, are sought to be identified based on available contextual data. By applying this approach, it is also possible to some degree to address issues such as psychological influences or other hidden factors potentially biasing interpretations of pathological changes in skeletal human remains. Therefore, despite the limitations of palaeopathology outlined above, by applying a biocultural approach and analysing human remains within their cultural, environmental, political and social context gained from archaeological, anthropological, palaeoenvironmental and historical data it is nevertheless possible to gain an insight into health and disease in past human societies (e.g. Bush & Zvelebil, 1991, Larsen, 1997: 4, Roberts & Cox, 2003).

4.2.4. Evolutionary perspectives on human health

The human disease spectrum is not static but represents a constantly changing system that has evolved from the beginnings of humanity onwards and is continuing to do so. As a consequence, understanding the evolutionary processes that shaped both pathogens as well as human response to these agents is crucial for understanding, but also for finding ways to cure diseases affecting us today (Nesse & Williams, 1994, Stearns *et al.*, 2010, Stearns, 2012). Several key processes and trends have been identified in the emerging field of evolutionary medicine as central to the formation and development of the spectrum and patterns of diseases affecting humans today (Stearns *et al.*, 2010, Stearns, 2012). In evolutionary approaches, disease is seen as an organism's failure to adapt to external conditions (McKenna *et al.*, 1999, Zuckerman *et al.*, 2012: 3). Biological evolution is much slower than cultural change (Stearns *et al.*, 2010). Consequently, many modern diseases such as cancer or cardiovascular diseases simply reflect the human body's inability to adapt to new environmental influences (McKenna *et al.*, 1999: 3, Stearns, 2012). Understanding human genetic variability is another important aspect as it can influence susceptibility to disease as well as our ability to metabolise dietary components such as milk, alcohol and different types of drugs (Stearns, 2012). The relationship between host and pathogen, representing a complex, constantly evolving system driven by environmental and other selective forces, is another area of medical research which largely benefits from evolutionary approaches (Stearns, 2012). This is particularly relevant in light of emerging infectious diseases and increasing drug-resistance (Barrett *et al.*, 1998). Another major theme in evolutionary medicine is ageing because the evolution of longevity in humans has increased susceptibility to many infectious and degenerative diseases such as cancer (Stearns *et al.*, 2010, Stearns, 2012).

In order to understand these evolutionary dynamics that shaped our modern disease environment, understanding the antiquity and palaeoepidemiology of diseases represents a crucial element. Archaeological human remains are a key resource for any such attempts. Integrated with contextual data about the environmental, cultural and social background of the population under study, such studies can allow for important insights into the evolution of host-pathogen-relationships, origins of genetic variability as well as the risk factors associated with many modern diseases, including cancer, atherosclerosis or diabetes (e.g. Dupras *et al.*, 2010, Zuckerman *et al.*, 2012, Binder *et al.*, 2014). New scientific methods now allow for far more detailed insights, exemplified by recent attempts to characterise the genome of the human oral microbiome through archaeological dental calculus (Warinner *et al.*, 2014). Another study of calculus has recently shown shifts in the oral flora occurring as a consequence of dietary changes with the onset of the agricultural transition and during industrialisation (Adler *et al.*, 2013). Dental disease is receiving increasing attention as a major contributor to many human diseases, particularly cardiovascular diseases which represent the world's leading cause of death today (Rosenfeld & Campbell, 2011). Understanding the evolution of the oral flora as the substratum for pathogens causing dental diseases therefore represents a key element in finding new ways for treatments and cures, and emphasising preventive measures. In cancer research, biomolecular research has already provided some insights into ancient cancer genomics (Fornaciari *et al.*, 1999, Schlott *et al.*, 2007) and may in future provide further insights into the evolution of cancer and its susceptibility in human populations.

In turn, palaeopathological studies also need to take an evolutionary perspective in order to enable exchange with modern medical research and to set results into a wider perspective (Armelagos *et al.*, 2005, Zuckerman *et al.*, 2012, Binder *et al.*, 2014). This particularly requires a biocultural approach to the study of archaeological remains, considering the social, cultural, environmental and economic factors within and between populations that can significantly influence the relationship between host, pathogen and environment but also the human genome in itself (Zuckerman *et al.*, 2012).

4.3. Background to indicators of stress and disease used in this study

4.3.1. Demography

Demography, referring to the statistical study of the human population, aims to measure population size, growth or diminution. On an individual level, the basic demographic parameters are sex and age (Chamberlain, 2006: 2). Resulting from a function of birth, death and migration, the demographic structure of a population, whether past or present, provides important information about fertility, mortality and migration (Cox, 1976: 1–2, Chamberlain, 2006: 1–3). Consequently, systematic studies of palaeodemography can hold important information about past human populations and processes in human history, such as population responses to subsistence and climatic change, expansion, migration and colonisation, or the interplay of population density and infectious diseases (Chamberlain, 2006: 178). The most important demographic parameter in bioarchaeological studies of population health is age-at-death because premature death represents the ultimate failure of the organism to respond to a negative influence (Goodman & Martin, 2002). This is exemplified by the significant rise in life expectancy and decline in sub-adult mortality, accompanying the development of modern medical care and consecutive shifts from infectious to degenerative diseases as the main cause of death occurring in European and American countries during the 19th and 20th century (McKeown, 2009).

Based on uniformitarian assumptions, demographic models of past human populations are generally derived from comparison with historic and modern data. These models presuppose a stationary population. As Chamberlain states: “Although human societies are extraordinarily diverse, the demographic structure of any viable (i.e. self-sustaining, demographically stable) population can be located within a limited range of possibilities” (Chamberlain, 2006: 177). However, stationarity appears to be difficult to infer for past human populations and could therefore potentially lead to erroneous inferences when interpreting the demographic structure of past human populations based on skeletal remains as a single source of evidence (Wood *et al.*, 1992). This is particularly the case in a colonial setting like Amara West where textual evidence does indicate a certain degree of movement of traders or colonial officials coming in from

Egypt proper and beyond. Bearing these caveats in mind, the outcomes of demographic analysis will be discussed in the following.

Demographic reconstructions in archaeological populations are faced with a number of theoretical and methodological problems (e.g. Bocquet-Appel & Masset, 1996, Chamberlain, 2006). One of the major limitations is set by the inadequacy of methods available to infer age-at-death from adult skeletal human remains that at present do not allow for precise estimates of age-at-death (for a discussion see Section 7.2.7). Differential preservation of the skeletal remains due to chemical, physical or mechanical properties of the soil in which people were buried can also significantly bias the demographic profile obtained from archaeological human remains (Chamberlain, 2006: 12). Due to low or decreased thickness and density, skeletal elements of both very young and very old individuals appear to be much more prone to taphonomic damage and therefore more likely to be invisible in the archaeological record than young and middle adults (Mays, 2010: 21–22). However, preservation conditions at Amara West are relatively good, and thus age-related differences in preservation appear rather unlikely.

4.3.2. Stature

Skeletal growth is a continuous process occurring between initial formation of bone *in utero* until the end of adolescence (Scheuer & Black, 2000b). Even though it is generally genetically determined, a large number of factors such as malnutrition, infectious disease, psychological and socio-economic factors can lead to significant disturbances and alterations of this process (Larsen, 1997: 8). As a consequence, growth rates in children are a widely used marker of population health in modern (e.g. Eveleth & Tanner, 1990, WHO, 2014) and past human populations (e.g. Larsen, 1997: 8–19, Goodman & Martin, 2002, Saunders, 2008). Studies of growth based on archaeological human remains are usually based on comparison of long bone length with modern growth standards reflecting growth in healthy, well-nourished children (e.g. Hummert & Van Gerven, 1983, Hoppa, 1992, Saunders, 2008). Widely used standards in bioarchaeological research were devised by Maresh (1943, 1955) from a sample of healthy middle-class children in Denver, Colorado and may potentially not be applicable to populations of different ethnic or geographic origin. More recent standards were established by the WHO (2014) and designed to reflect growth under optimal conditions regardless of ethnicity or socio-economic status. The ultimate product of genetic potential and health and nutrition during childhood is adult stature (Larsen, 1997: 13). Consequently, stature is an equally useful marker of health, living conditions or socio-economic status in modern and past human populations (Komlos, 1985, Steegmann, 1985, Larsen, 1997: 13–18, Goodman & Martin, 2002). However, bioarchaeological studies of growth and stature are faced with a number of methodological limitations brought about by difficulties in accurately estimating sub-adult age as well as adult stature. These will be discussed in more detail in Chapter 8.

4.3.3. Dental disease

4.3.3.i. Caries

Dental caries is the progressive demineralisation and destruction of dental hard tissue (enamel, dentine and cementum) caused by organic acids which are produced by bacteria present in dental plaque during fermentation of carbohydrates in the diet (Hillson, 2008). Initially, caries usually affects the dental enamel of tooth crowns, with molar fissures and approximal surfaces being those most frequently involved (Hillson, 2001). As the disease progresses, the underlying dentine becomes involved. Ultimately, demineralisation spreads into the pulp chamber where it triggers an inflammation of the pulp which consequently can lead to secondary inflammation and abscess formation surrounding the apex of the tooth (Hillson, 2005: 291).

Dental caries represents one of the oldest (Lanfranco & Eggers, 2012) and still the most common infectious disease in human populations (Balakrishnan *et al.*, 2000). Despite its long history, caries appears to have been relatively rare until the transition from hunter/gather to an agriculturally based lifestyle (Aufderheide & Rodríguez-Martín, 1998, Lanfranco & Eggers, 2012). With the shift to agriculture the composition of the diet changed to a high carbohydrate content. Recent research on microbial aDNA present in ancient dental calculus has shown that those changes significantly altered the oral microbial community towards a configuration facilitating dental diseases (Adler *et al.*, 2013). A large variety of factors are involved in the aetiology of dental caries (Lukacs, 2012). The main group of bacteria responsible for caries formation are *Streptococcus mutans* (Balakrishnan *et al.*, 2000). Amongst the dietary carbohydrates, sugars, and first and foremost sucrose, were identified as the most important causal agent for the development of caries (Hillson, 2005: 291). The relationship of sucrose to other carbohydrates such as starch is less clear (Lingström *et al.*, 2000). In recent years, a lot of attention has been paid to understanding of the complex system of genetic determinants in the aetiology of caries (Peterson *et al.*, 2011, Lukacs, 2012). Studies have shown a genetic predisposition to caries (Vieira *et al.*, 2008, Küchler *et al.*, 2013), genomic variants in oral bacterial flora (Yang *et al.*, 2014) and genetic variations in enamel formation (Shimizu *et al.*, 2012) increasing the risk of caries. Furthermore caries prevalence has been found to be consistently higher in women than in men, both in bioarchaeological (e.g. Larsen, 1997: 72–76) and modern clinical studies worldwide (e.g. Lukacs & Largaespada, 2006, Lukacs, 2011). Several factors seem to account for these differences including sex differences in the microbiological composition of saliva, hormonal fluctuations influencing the oral flora, genetic differences leading to increased susceptibility in women but also a large number of psychological and socio-cultural influences (reviewed by Lukacs & Largaespada, 2006, Ferraro & Vieira, 2010).

4.3.3.ii. Dental calculus

Dental calculus is very common in both archaeological (Lieverse, 1999, Hillson, 2005: 289) as well as modern populations worldwide, with prevalence rates up to 100% in populations without access to oral health care (e.g. White, 1997). It results from the mineralisation of dental plaque, and an accumulation of microorganisms (bacteria, viruses, yeasts, protozoa) on teeth (Hillson, 2005: 286, 288). Calculus comprises an organic (10–15%; amino acids, proteins, glycoproteins, carbohydrates, peptides and lipids) and an inorganic component (Hillson, 1996: 255). The mineral fraction, mainly calcium phosphates, derives from the saliva (Jin & Yip, 2002). As a consequence, deposition is usually highest in areas close to the salivary glands, i.e. the lingual surface of the incisors and canines as well as on the buccal sides of upper molars (Hillson, 1996: 255–256). Calculus is usually classified into supra-gingival and sub-gingival calculus, differing from each other in composition and structure (Hillson, 1996: 256). The mechanism triggering mineralisation is not yet fully understood (Jin & Yip, 2002, Hillson, 2005: 255). Diet however has been shown to be a major influence on calculus formation (Lieverse, 1999). Precipitation of minerals from the saliva is facilitated by an alkaline oral environment (Hillson, 1979, Jin & Yip, 2002). Diets high in protein have been shown to significantly increase alkalinity (Hillson, 1979). Modern clinical studies have found calculus prevalence to significantly correlate with ethnicity even though it remains to be clarified whether this is genetically determined or rather due to cultural and environmental differences (Christersson *et al.*, 1992, White, 1997, Mason, 2009).

4.3.3.iii. Periapical lesions

Pathological lesions in the periapical region of the periodontial tissues generally result from an infection of the tooth pulp by oral bacteria if the pulp is exposed by caries, attrition or trauma (Dias & Tayles, 1997). Several types of periapical lesions can be distinguished (Dias & Tayles, 1997, Ogden, 2008). Following infection and inflammation, the tooth pulp usually dies and necrotises. Consequently, this causes inflammation of the tissues surrounding the apex, which eventually develops into a small soft tissue sphere that also creates a void in the periapical bone. These initial changes are referred to as a granuloma and are manifested as small circular, smooth walled defects in dry bone (Ogden, 2008). As the process continues, granulomata commonly develop into liquid filled periapical cysts (Dias & Tayles, 1997). An abscess forms if an acute pyogenic infection in the periapical tissue is present (Dias & Tayles, 1997). While in its acute form, the infection only affects soft tissue, in chronic abscesses large amounts of pus lead to formation of voids within the bone to allow for drainage of the pus into the oral cavity (Dias & Tayles, 1997). Correct terminology and differentiation between different types of periapical lesion in dry bone has been the subject of some debate in the palaeopathological literature as most researchers simply refer to all pathological fenestrations in dental bone as abscesses (Dias & Tayles, 1997, Dias *et al.*, 2007, Ogden, 2008). Morphologically, granulomata and cysts only differ from each other in size, with cysts exceeding a diameter of 3mm (Dias & Tayles, 1997). If a periapical abscess develops from a granuloma or cyst, it will lead to roughening of the otherwise smooth wall of the cavity (Dias & Tayles, 1997). A chronic abscess can be diagnosed if the walls of the cavity are rough and ragged and a bony sinus draining into the oral or sinus cavity is present (Ogden, 2008). Additionally, abscesses also commonly feature deposits of new bone formation surrounding the opening of the drainage (Dias & Tayles, 1997, Ogden, 2008). More thorough palaeopathological studies have shown that the vast majority of periapical lesions present in archaeological human remains are in fact granulomata or cysts (Dias *et al.*, 2007, Ogden, 2008). This also corresponds with modern clinical studies (Stockdale & Chandler, 1988, Ramachandran Nair *et al.*, 1996). Understanding the underlying cause of observed periapical lesions has further implications for inferences about the health of the individual. While granulomata and cysts represent benign processes, a true periapical abscesses represents a serious pathological insult and can potentially be fatal (Dias & Tayles, 1997, Ogden, 2008).

4.3.3.iv. Periodontal disease

Periodontal disease is clinically defined as the intermittent degeneration of the supporting tissue (gingiva, cementum, periodontal ligament, and alveolar bone) of teeth (Hildebolt & Molnar, 1991). The disease starts in the gingiva and progressively leads to bone loss. Bone loss advances and ultimately leads to tooth loss once bone recedes to a degree that support and attachment of dental ligaments is lost (Hildebolt & Molnar, 1991). The most common form of periodontal disease is adult or chronic periodontitis, which represents a progressive chronic inflammation of periodontal tissues that is usually caused by pathogens present in dental plaque (Hillson, 1996, Ubertalli, 2012: 262). Aside from infectious agents, several systemic diseases such as diabetes, Crohn's disease or Vitamin C-deficiency, but also dietary factors, malocclusion, tooth wear and genetic reasons, significantly increase the risk of periodontitis (Hildebolt & Molnar, 1991, Ubertalli, 2012).

One of the main difficulties in diagnosing periodontal disease in skeletal human remains lies in the fact that alveolar bone loss can be caused by a number of mechanical and pathological processes, periodontitis being only one of them (Clarke & Hirsch, 1991b, Glass, 1991, Ogden, 2008). Diagnostic criteria for alveolar bone loss caused by periodontitis comprise generalised resorption of the cortical bone and consequent exposure of the underlying spongiosa which ultimately leads to rounding of the alveolar margin and loss of form (Clarke & Hirsch, 1991b). Bone loss in the dentition can also be caused by infection of the tooth pulp even though this usually leads to a localised defect. In contrast to periodontal disease, the alveolar crest remains intact (Clarke & Hirsch, 1991b). However, there are also a number of non-pathological factors leading to alveolar bone loss, including facial growth, and attrition which results in continued growth of teeth to compensate for the loss of occlusal distance (Clarke & Hirsch, 1991b, Glass, 1991, Ogden, 2008). This is often overlooked in the analysis of past human populations, which potentially leads to a gross overestimation of the prevalence of periodontal disease (Clarke & Hirsch, 1991b). In modern clinical studies, the prevalence of advanced periodontal disease with loss of alveolar bone has been shown to be very variable with up 74% in African populations but only 22% in North and South American groups (Lindhe *et al.*, 2008: 138), even though comparability of studies is somewhat limited by different diagnostic criteria used to assess periodontal disease in clinical contexts (Lindhe *et al.*, 2008: 131–133). Periodontal disease has recently become the centre of attention of clinical researchers because studies have shown a causal link with cardiovascular diseases (Demmer & Desvarieux, 2006, Rosenfeld & Campbell, 2011).

4.3.3.i. Dental enamel hypoplasia

Dental enamel hypoplasia is a form of defect or disruption in the development of dental enamel which is manifested as a deficiency in enamel thickness resulting from insufficient matrix secretion (Suckling, 1989, Hillson, 1996: 165, Seow, 1997). They are amongst the most common pathological changes reported in archaeological human remains (e.g. Larsen, 1997: 50–56, Steckel & Rose, 2002, Roberts & Manchester, 2005: 75–77) and are still frequently encountered in modern human populations (Seow, 1997, Seow, 2013). Enamel hypoplasias occur in three different forms: pits, grooves or larger areas of missing enamel (Hillson, 1996: 167). By far the most common form in modern clinical practice as well as in the palaeopathological record are horizontal linear grooves, also referred to as linear enamel hypoplasia (Hillson, 1996: 166, Seow, 1997). Defects start on a microscopic level (King *et al.*, 2005, Hassett, 2014) even though in the majority of bioarchaeological studies diagnosis is usually confined to defects macroscopically discernible (Buikstra & Ubelaker, 1994: 56). A large number of factors can lead to disruptions in enamel formation including malnutrition and dietary deficiencies, a wide range of infectious diseases, Crohn's disease or diabetes (e.g. Pindborg, 1982, Goodman & Rose, 1990, Goodman *et al.*, 1991, Hillson, 1996: 166, 171, Ogden, 2008, Seow, 2013). In addition, they can result from congenital disorders and localised trauma, even though this is generally rather rare (Goodman & Rose, 1991, Seow, 1997). Differentiating between different causes is difficult. Trauma is usually localised and therefore only affects one tooth, whereas systemic disturbances affect multiple teeth (Lukacs, 1991, Seow, 2013). As a consequence, they are recognised as a generalised marker of systemic physiological disturbance (e.g. Goodman & Rose, 1990, Larsen, 1997: 46, Goodman & Martin, 2002, King *et al.*, 2005).

4.3.4. Orbital lesions

Lesions in the roof of the eye socket, also referred to as "cribra orbitalia", are generally characterised by abnormal porosity and hypertrophy found on the orbital roof (Ortner, 2003: 370–371). In skeletal human remains, they represent a very common finding and have been observed in populations from around the world dating back as far as the Palaeolithic (Roberts & Cox, 2003: 43) and Mesolithic periods (Larsen, 1997: 33). The aetiology of porosities in the orbital roof is still debated (e.g. Wapler *et al.*, 2004, Walker *et al.*, 2009). In the palaeopathological literature porosities have most commonly been associated with anaemia (e.g. Stuart-Macadam, 1989a, Stuart-Macadam, 1991, Ortner, 2003: 370–371, Walker *et al.*, 2009) and assumed to result from an expansion of the haematopoietic bone marrow (Ortner, 2003: 375). Iron-deficiency anaemia due to inadequate intake or absorption of iron or excessive blood loss, represents the most common form of acquired anaemia and has been frequently associated with high levels of cribra orbitalia in past human populations (Stuart-Macadam, 1989a, Stuart-Macadam, 1991, Mittler & Van Gerven, 1994). This hypothesis has repeatedly been challenged in recent years because acquired iron-deficiency anaemia does not lead to marrow expansion and thus would not be expected to cause the changes observed in human remains (e.g. Wapler *et al.*, 2004, Waldron, 2009: 136–137, Walker *et al.*, 2009). However, it can occur in other forms of acquired anaemia, in particular megaloblastic anaemia which is most commonly caused by Vitamin B12 or folic acid deficiency, as well as haemolytic anaemia which is associated with malaria (Walker *et al.*, 2009). In addition, it has been shown that a large number of conditions can produce very similar lesions, such as cancer (Ortner, 2003: 375), infectious disease of the eye (Sandison, 1967, Wapler *et al.*, 2004) and metabolic diseases, particularly scurvy (Ortner & Ericksen, 1997). Even though histological analysis may contribute to revealing the true origin of the lesions (Schultz, 2001), macroscopically they are usually indistinguishable from each other. While it remains one of the most commonly cited pathological conditions in skeletal human remains, it has received almost no attention in the clinical literature. This may partially be due to difficulties diagnosing cribra orbitalia in the living, as it lies beyond the threshold of standard X-ray equipment even though it can be visualised by using computerised tomography (Exner *et al.*, 2004). Nevertheless, despite these differential diagnostic problems, cribra orbitalia still stands as a generally accepted marker of physiological stress in the skeleton that is frequently used in bioarchaeological studies of health in past human populations (e.g. Larsen, 1997: 35–40, Goodman & Martin, 2002, Buzon, 2006b).

In palaeopathological studies cribra orbitalia is commonly analysed in combination with porosities on the skull vault, also termed porotic hyperostosis, and assumed to be of similar aetiology (Stuart-Macadam, 1985, 1989b, Goodman & Martin, 2002). However, this association remains debated (Ortner, 2003: 372). Similar to cribra orbitalia, different underlying reasons including scurvy, rickets, cancer and inflammation of the scalp have been shown to lead to very similar lesions (e.g. Ortner & Ericksen, 1997, Ortner & Mays, 1998, Ortner, 2003: 375, Walker *et al.*, 2009). While lesions caused by anaemia lead to expansion of the diploe, new bone formation subsequent to an inflammatory response leads to thickening of the outer table but does not affect the marrow space (Ortner, 2003: 375). Consequently, differential diagnosis can only be achieved through radiography. Within the framework of this study, systematic radiography was not carried out on the skeletal remains from Amara West. Therefore, and due to the known uncertainties about the aetiology of porotic hyperostosis, the condition was not included in this study.

4.3.5. Infectious diseases

4.3.5.i. Introduction

Before the introduction of modern medical care and the development of antibiotics, infectious diseases represented the most common cause of death in human populations. Infectious diseases comprise a wide variety of pathological conditions and can be caused by a large number of viral, bacterial, parasitic or mycotic pathogens (Kumar *et al.*, 2013: 310). An infectious agent can be spread by contact (direct or indirect), via respiratory droplets, the fecal-oral route, sexual transmission, vertical transmission from mother to fetus or a newborn baby, or via insect/arthropod vectors (Kumar *et al.*, 2013: 319). Infection occurs if the agent overcomes the normal host immune defences or if the defence of the host is compromised by external factors such as other diseases, malnutrition, age or psychological stress (Kumar *et al.*, 2013: 319). In addition to individual parameters, environmental influences such as population density, personal hygiene, climatic conditions or housing, as well as the virulence of a pathogen, can further influence the transmission and progression of infectious diseases (Ortner, 1991, Meade & Earickson, 2000). The pathomechanism of infection initially involves inflammation of the affected tissue, which represents a cellular response to an invading pathogen. Inflammation represents a protective response of the host cells, blood vessels, and proteins and other mediators with the purpose of eliminating the initial cause of cell injury, as well as the necrotic cells and tissues resulting from the original insult. If the organism survives the pathological insult, inflammation further initiates repair (Kumar *et al.*, 2013: 29). Depending on the speed of onset, type of insult, virulence of the pathogen and immune response, inflammation can either be acute or chronic (Kumar *et al.*, 2013: 29). In acute infection, the stimulus can either be eliminated, leading to decline of the reaction and consequent repair or if elimination is not achieved, rapid death of the organism.

Infection of bone can be either primary, or secondary through dissemination from a soft tissue infection (Resnick & Niwayama, 1995: 2326). The skeletal changes brought about by an infection affecting bone are usually manifested through new bone formation (by far the more common) or bone resorption or a combination of both (Kelley, 1989, Ortner, 2003: 181). Due to the physiological properties of bone, response to an inflammatory process is usually very slow, and therefore those infectious diseases affecting the skeleton tend to be sub-acute or chronic infections (Ortner, 1991, Ortner, 2003: 181). Differential diagnosis of infectious diseases in human remains is problematic due to the fact that a large number of infectious diseases lead to very similar changes in the skeleton. Consequently, in palaeopathology it is common to separate infectious diseases into specific infections which can be linked to a specific organism such as tuberculosis, leprosy or treponemal diseases, and non-specific infections which can be caused by a variety of different agents (Roberts & Manchester, 2005: 168).

4.3.5.ii. Non-specific infections

The vast majority of skeletal changes associated with an infectious disease are non-specific. The most common infectious agents involved in bone infection today are staphyloccoci, streptococci and pneumocci (Roberts & Manchester, 2005: 168). Depending on the type of skeletal tissue affected, infections are categorised into osteomyelitis (bone marrow), osteitis (bone cortex) and periostitis (periosteum) (Resnick & Niwayama, 1995: 2326, Ortner, 2003: 181). Differentiation between osteomyelitis and osteitis can only be achieved by applying radiographic techniques and is considered difficult even in the clinical context (Resnick & Niwayama, 1995: 2326). In palaeopathological studies, osteitis is relatively rarely diagnosed (Larsen, 1997: 83, Roberts & Manchester, 2005: 168) Osteomyelitis involves bone resorption, pus formation and bone repair leading to expansion both on the periosteal and endosteal sides of the bone (Resnick & Niwayama, 1995: 2335). In up to 90% of cases, osteomyelitis is caused by *Staphylococcus aureus*, spreading to bone through an open wound, from a soft tissue focus in the vicinity, or through haematogenous dissemination from a distant infectious origin (Ortner, 2003: 181). While osteomyelitis is only rarely diagnosed, by far the most common form of non-specific infection in archaeological human remains is periostitis (Larsen, 1997: 84). An inflammatory response in the periosteum leads to stimulation of the periosteal osteoblasts, typically manifested through fine pitting and new bone formation (NBF) (Freyschmidt, 1993: 512). Periostitis can occur as a primary phenomenon but also secondary to a large number of other systemic infectious diseases (Weston, 2008). In addition, inflammation of the periosteum leading to new bone formation can be caused by a mechanical stimulus but also cancer, vascular disorders or metabolic diseases such as scurvy or rickets (Freyschmidt, 1993: 513–514, Ortner, 2003: 206–207, Weston, 2008). In the absence of further differential diagnostic features, it is considered impossible to attribute periosteal new bone formation to a more specific cause (Weston, 2008).

New bone formation, particularly in the long bones is a very common finding in archaeological human remains (e.g. Larsen, 1997: 84, Roberts & Manchester, 2005: 172). Due to the difficulties surrounding the differential diagnosis of infectious diseases in human skeletal remains, NBF in the long bones has become a frequently used proxy for the presence of infectious disease in past human populations (Larsen, 1997: 84, Goodman & Martin, 2002). However, the main problem of this approach lies in the fact that NBF is by no means exclusive to infectious diseases but can result from any pathological or mechanical insult leading to inflammation of the periosteum (Weston, 2008). Therefore, caution is warranted when inferring levels of infectious diseases in a population from NBF in the long bones.

4.3.5.i. Infections of the respiratory tract

4.3.5.i (a) Maxillary sinusitis

Maxillary sinusitis represents one of the most common chronic diseases in modern human populations worldwide, particularly in children (Brook, 2012). It is defined as an inflammation of the mucous membrane inside one or more paranasal sinuses (maxillary, ethmoid, sphenoid and frontal sinuses) (Slavin *et al.*, 2005). Inflammation of the sinuses is mainly caused by bacterial (most commonly), fungal or viral infections (Brook, 2012). Important predisposing risk factors are allergenic rhinitis, nasal polyps as well as environmental pollution because particles can cause obstruction to the cilial function, inhibiting drainage of the sinus and leading to accumulation of pathogens and consequent infection (Trevino, 1996, Roberts, 2007). Dental diseases, in particular periapical lesions in the upper molars, can further lead to secondary infection of the maxillary sinuses (Mehra & Jeong, 2009). If inflammation of the sinus mucosa reaches a chronic state, new bone formation can be triggered, allowing for a detection in archaeological human remains (e.g. Boocock *et al.*, 1995b, Roberts, 2007).

4.3.5.i (b) Pulmonary diseases

Lung diseases comprise a large number of different conditions of infectious and non-infectious origin, including tuberculosis, pneumonia caused by infections with *Staphylococcus*, *Streptococcus* or other bacterial and viral agents, mycosis, cancer, asthma and aspergillosis, or inhalation of external material (Mason, 2010). In the skeleton, pulmonary diseases can be inferred through the presence of new bone formation on the visceral surfaces of the ribs, which is caused by secondary spread of chronic inflammatory conditions of the lung and lung pleura to the periosteum of the ribs (Roberts *et al.*, 1994). In palaeopathological research, the disease most commonly associated with new bone formation in the ribs is tuberculosis (e.g. Kelley & Micozzi, 1984, Pfeiffer, 1991, Roberts *et al.*, 1994, Roberts *et al.*, 1998, Matos & Santos, 2006, Santos & Roberts, 2006). This has gained further support through recent studies providing biomolecular evidence of TB in individuals where rib lesions have been found, even though the results are still far from conclusive and therefore a direct association cannot be proven with certainty (e.g. Nicklisch *et al.*, 2012, Müller *et al.*, 2014). Corresponding data from the clinical literature is very rare. However, a radiographic study by Eyler *et al.* (1996), found enlargement of ribs (assumed to originate from NBF) to be most common in patients with TB, even though it was also found in association with other forms of chronic lung disease. However, research on historical collections with known cause of death have also shown that the changes are not pathognomonic (Roberts *et al.*, 1994, Santos & Roberts, 2006). Even though attempts have been made to distinguish between different underlying causes based on the distribution of lesions both within the rib cage and in different areas of the rib, this has not yet led to unambiguous results (Roberts *et al.*, 1994, Matos & Santos, 2006, Santos & Roberts, 2006). Thus, in order to identify the exact underlying cause of observed rib lesions further differential diagnostic changes in the bones or biomolecular evidence is required.

4.3.5.ii. Pathological changes on the endocranial surface of the skull

Changes on the endocranial surface of the skull, manifested through new bone formation, particularly along the venous sinuses and meningeal impressions, increased vessel impressions and porosity on the inner table of the skull bones, are another commonly observed indicator of disease in past human populations (e.g. Mensforth *et al.*, 1978, Schultz, 2001, Hershkovitz *et al.*, 2002, Lewis, 2002, Lewis, 2004, Roberts & Manchester, 2005: 177–178) The changes are assumed to result from an inflammation of the meningeal vessels leading to new bone formation and increased vessel activity (Schultz, 1993, Czerny, 2001). Inflammation of the meninges (meningitis) is mainly caused by bacterial, viral, parasitic or fungal infections, but can also arise from non-infectious diseases such as cancer and metabolic diseases. Clinically, meningitis can be classified into acute, sub-acute and chronic forms (Greenlee, 2013b). Chronic meningitis, persisting for at least four weeks, is mainly associated with bacterial infections (tuberculosis, Lyme disease), but also fungal infections, sarcoidosis or several types of cancer (Greenlee, 2013a). In palaeopathological studies, there is some debate about whether meningitis, particularly that seen in children, can be survived long enough to cause a bony response (Roberts & Manchester, 2005: 178). In addition, inflammation of the meningeal vessels has been linked to scurvy and used as an explanation for the observed changes on the endocranial surface (Brickley & Ives, 2006, Brown & Ortner, 2009). Cranial trauma, leading to endocranial bleeding, can also account for new endocranial bone deposition. Differentiating between different causes of chronic meningeal inflammation remains difficult and could only be achieved through additional diagnostic criteria. This is further impeded by the fact that while endocranial skeletal changes are frequently cited in the palaeopathological literature, references in the clinical literature are almost absent (Schmitt, 1979: 48, Schultz, 1993) even though they have been recognised for a long time (e.g. Koganei, 1911). This shortcoming has partly been attributed to methodological reasons since the lesions lie beyond the threshold of standard X-ray equipment (Resnick & Niwayama, 1995: 2350).

Palaeopathological research has mainly focused on endocranial changes in sub-adult individuals as they tend to be a lot more commonly affected than adults (Schultz, 1993, Lewis, 2004). Schultz concluded from the absence of endocranial changes in several historic and pre-historic collections from Central and Western Europe that chronic encephalitis only rarely affected adult individuals (Schultz, 1993: 54). However, Hershkovitz and co-workers (2002) found 1.7% of adult individuals in the documented post-medieval Hamann-Todd-collection showed new bone formation on the inner table of the skulls Amongst the affected individuals, all but one died of an inflammatory disease, with 78.5% having TB listed as cause of death. Consequently, they suggested a link between endocranial new bone formation and TB as well as chronic pulmonary diseases in general.

4.3.6. Diseases of the joints

4.3.6.i. Osteoarthritis

The most common form of joint disease in modern clinical as well as archaeological contexts worldwide is osteoarthritis (Ortner, 2003: 545, Waldron, 2009: 26, Lozada, 2013) occurring in the synovial joints of the body which, due to their physiological and biomechanical properties, are by far the most commonly affected types of joints (Waldron, 2009: 24). Synovial joints, accounting for the majority of joints in the body, are characterised by a space between the two articulating ends of the bones which allows for movement of the bones comprising the joint (Schiebler & Korf, 2007: 161–162). Surrounded by a fibrous joint capsule and the joint cavity being lined with synovial membrane, the two ends of the bones (joint surfaces) are covered by hyaline cartilage. The gap between the two joint surfaces is filled with liquid (synovial fluid) containing nutrients for the joint cartilage. Depending on the shape of the joint surfaces, movement is possible in different directions (Schiebler & Korf, 2007: 163).

Osteoarthritis results from a progressive degeneration of the articular cartilage (Waldron, 2009: 27–28). After initial breakdown and erosion of the cartilage, in advanced stages inflammation of the synovial membrane occurs. Consecutively the bones involved in the joint respond to the inflammation with formation of new bone. The subsequent changes observed in the underlying joint surfaces of the bones are new bone formation around the joint margins (osteophytes), new bone deposition on the joint surfaces, pitting of the joint surfaces (porosities), changes in the normal joint contour, and polished areas (eburnation) resulting from bone-on-bone contact after complete erosion of the joint cartilage. Traditionally, both clinical and palaeopathological literature refer to osteoarthritis as a degenerative disease (e.g. Bridges, 1991, Jurmain & Kilgore, 1995, Ortner, 2003: 545). However, new research has shown, that inflammation is an important pathophysiological feature of osteoarthritis and therefore it should not be described as degenerative disease (Waldron, 2009: 27, Lozada, 2013).

The exact aetiology of osteoarthritis remains unknown. Together with major risk factors such as age, sex, genetic background and obesity, the most important influence is activity because, without movement, joints do not develop osteoarthritis (Waldron, 2009: 28). This hallmark prerequisite of osteoarthritis underlies the disease's use in palaeopathology. Based on this assumption, the prevalence of joint disease (osteoarthritis) on a population level can hold significant information about activity levels and patterns, modes of subsistence and general workload within the group under study (e.g. Merbs, 1983, Kilgore, 1984, Bridges, 1991, Larsen, 1997: 167–189, Schrader, 2012). However, both clinical and archaeological research have failed to establish a conclusive link between specific activities and patterns of osteoarthritis, and therefore more detailed inferences about activity and occupation in past human populations remain problematic (Jurmain & Kilgore, 1995, Weiss & Jurmain, 2007)

4.3.6.ii. Intervertebral disc disease (IVD)

Intervertebral disc disease (IVD) refers to the degeneration of the intervertebral disc (Waldron, 2009: 42). Its aetiology is clearly linked to ageing, genetic inheritance and metabolite transport and can occur in all areas of the spine (Adams & Roughley, 2006a). IVD is frequently found in archaeological human populations (Bridges, 1991, Roberts & Manchester, 2005: 139–141), corresponding with high prevalence rates in modern human populations worldwide (Adams & Roughley, 2006a). Clinical research has also shown IVD to increase with mechanical loading acting upon the spine (Stokes & Iatridis, 2004). The intervertebral disc consists of a nucleus surrounded by an annulus of dense, fibrous tissue. With increasing structural weakness, the annulus collapses and the nucleus bulges outwards. On the vertebral end plates this leads to pitting and marginal osteophytes which represent the characteristic skeletal features of IVD (Waldron, 2009: 43).

4.3.6.iii. Schmorl's Nodes

Named after German physician Christian Georg Schmorl (1863-1932), Schmorl's nodes (SN) refer to localised damage to the vertebral endplates resulting from a herniation of the vertebral disc into the trabecular bone (Waldron, 2009: 45). They are most commonly observed in the lower thoracic and upper lumbar spine. Even though their aetiologies are still debated, research has shown that their formation is linked to general degenerative processes resulting from high mechanical demand on the spine (Dar *et al.*, 2010). Other causes and risk factors include trauma, metabolic and neoplastic conditions as well as developmental disorders (Resnick & Niwayama, 1978). SN are very common in both bioarchaeological and modern clinical contexts, but their clinical relevance and impact on mobility and quality of life remain unclear (Faccia & Williams, 2008).

4.3.7. Trauma

Trauma represents one of the most commonly observed pathologies in skeletal human remains and can potentially reveal many aspects of past human life such as occupation, aggression and interpersonal violence, living environment and subsistence (Larsen, 1997: 109, Roberts & Manchester, 2005: 84). Definitions of trauma in the palaeopathological literature vary considerably between different authors (reviewed by Milner & Boldsen, 2012). A generally accepted definition was given by Lovell who defined trauma as *"an injury to living tissue that is caused by a force or mechanism extrinsic to the body"* (Lovell, 1997: 141). Consequently, there is also disagreement in the literature about the classification of trauma. While most authors use fractures and dislocations as main categories of trauma , others include wounds induced by weapons as well as a number of biomechanically induced injuries such as osteochondritis dissecans, spondylolysis, Schmorl's nodes and soft tissue exostoses (Lovell, 1997, Aufderheide & Rodríguez-Martín, 1998: 19–38, Ortner, 2003: 119, Roberts & Manchester, 2005: 84, Milner & Boldsen, 2012). Ortner (2003: 119) classifies trauma according to the associated changes into a partial to complete break in a bone, an abnormal displacement or dislocation of joints, a disruption in nerve and/or blood supply, and an artificially induced abnormal shape or contour of bone.

The most common form of trauma observed in skeletal human remains are fractures (Roberts & Manchester, 2005: 85). A fracture is defined as a complete or partial break in the continuity of the bone caused by mechanical stress applied to the bone (Ortner, 2003: 120). According to their aetiology, they are classified as traumatic or non-traumatic fractures (Baierlein, 2010: 1). Traumatic fractures are further subdivided into direct or indirect trauma depending on the mechanism of injury. In direct trauma, the fracture occurs at the site of impact. Indirect trauma leads to fractures in a site distant to the impact (Lovell, 1997). Non-traumatic fractures comprise stress-fractures and pathological fractures (Baierlein, 2010: 1). The morphological characteristics of fractures differ according to force, agent and site of impact (Baierlein, 2010: 2–3). Fractures due to direct trauma are either penetrating, transverse, comminuted or crush fractures, while indirect fractures are manifested as oblique, spiral, greenstick, burst, impacted or avulsion fracture (Lovell, 1997).

Fracture healing is usually initiated immediately after the fracture (Lovell, 1997: 144). Over the course of the healing process new bone (callus) is formed surrounding the fracture margins and ultimately usually leads to complete union of fracture elements unless severe non-apposition of fracture fragments occurs. Timing and duration of the healing process depends on the type of fracture, the element affected and many other factors such as age and overall health of the individual (Lovell, 1997). Fractures in cancellous bone generally heal faster than those in tubular bones, and long bones of the lower extremity tend to take more time healing than those of the upper extremity (Lovell, 1997).

Chapter 5. Background to the study of stable isotopes

5.1. Stable isotopes – basic principles

Isotopes are variations of an element with the same number of protons but a different number of neutrons in their core. A certain number of isotopes of most elements occur naturally, while additional ones can be created under laboratory conditions. While some isotopes are radioactive and decay at distinctive rates over time by emitting subatomic particles, others do not change and are thus called stable (Brown & Brown, 2011: 80). The stable isotopes most relevant in palaeodietary studies are carbon ($^{12}C/^{13}C$) and nitrogen ($^{14}N/^{15}N$) and to a lesser degree oxygen ($^{16}O/^{18}O$). Mass differences of isotopes of the same element can have a major influence on the way they react during physical and chemical processes. Consequently, the initial and the resulting components of a reaction can have different ratios which is termed isotope fractionation (Brown & Brown, 2011: 81). It is calculated as:

$$\delta = \left(\frac{R_{sample}}{R_{standard}} - 1 \right) x\ 1000$$

and should be noted in per mill (Coplen, 1996). The application of stable isotope analysis in archaeological research is based on the principle that the isotopic composition of the tissue of the consumer reflects the isotopic composition of the consumed diet (van der Merwe & Vogel, 1978, Krueger & Sullivan, 1984, Longinelli, 1984). In this study only stable carbon and oxygen isotopes were analysed, the basic principles will be introduced in the following.

5.2. Stable carbon isotopes

The use of stable carbon isotopes in palaeodietary studies is based on the fact that there are differences in carbon isotope fractionation during photosynthesis between different types of plants (van der Merwe & Vogel, 1978). In C_3-plants, including most major temperate crops such as emmer, wheat and barley, fractionation during photosynthesis occurs in two stages leading to enrichment in ^{12}C. In contrast, C_4-plants comprising maize, sugar cane and tropical crops such as sorghum and millet use only one stage in carbon isotope fractionation which results in tissue enriched in ^{13}C

compared to C_3 plants (Katzenberg, 2008, Brown & Brown, 2011: 82–83). Therefore, while $\delta^{13}C$ values of C_3-plants range between -24‰ and -36‰ (Smith & Epstein, 1971, Brown & Brown, 2011: 82), those of C_4-plants range between -9‰ and -14‰ (Smith & Epstein, 1971, Katzenberg, 2008: 423). In marine plants the carbon source is dissolved bicarbonate which is enriched in ^{13}C compared to the atmospheric carbon dioxide resulting in higher $\delta^{13}C$ values ranging around -20‰ (Brown & Brown, 2011: 83). $\delta^{13}C$ is measured in relation to the VPDB standard (Vienna Pee Dee Belmnite, Coplen, 1996). Due to the burning of fossil fuels, the $\delta^{13}C$-value of atmospheric CO_2 has decreased by -1.5‰, and therefore ancient plants have $\delta^{13}C$-values by 1.5‰ more positive than modern plants (Marino & McElroy, 1991). However, a number of environmental factors have been shown to influence the $\delta^{13}C$-values of plants leading to 1–2‰ variability (O'Leary, 1995, Heaton, 1999), and several studies have found evidence that aridity generally leads to slightly higher $\delta^{13}C$-values (e.g. O'Leary, 1995, Stewart *et al.*, 1995, Cerling & Harris, 1999, Kohn, 2010).

The differences in the isotopic composition of different plant types are reflected in the $\delta^{13}C$-values of tissue of the consumer allowing for a reconstruction of the diet consumed by animals and people in the past. A large number of experimental feeding studies in animals have focused on diet–tissue spacing (Krueger & Sullivan, 1984, Lee-Thorp *et al.*, 1989, Ambrose & Norr, 1993, Kellner & Schoeninger, 2007, Froehle *et al.*, 2010). Results have shown that the fractionation between diet and tissue of the consumer varies between type of tissue used for analysis (e.g. Ambrose & Norr, 1993, Jim *et al.*, 2004, Warinner & Tuross, 2009; for a more detailed discussion of different tissue types see below) but also between different animal species. The reasons for this are still under debate (Froehle *et al.*, 2010). Potential explanations have been sought in physiological and metabolic differences, dietary differences, body size as well as habitat (e.g. Cerling & Harris, 1999, Passey *et al.*, 2005, Warinner & Tuross, 2009, Froehle *et al.*, 2010). This variation also impacts on the values used for dietary reconstruction in humans. In collagen, the most widely used tissue in palaeodietary studies, an average fractionation factor of 5‰ is now widely in use (van der Merwe & Vogel, 1978, White *et al.*, 2004). The second main source of carbon in dietary studies is apatite in tooth enamel and bone. Diet–tissue spacing is higher than in collagen, ranging between 9 and 11‰ in studies of lab rodents and 12–14‰ in different herbivorous ungulate species (Passey *et al.*, 2005). According to a recently devised model based on compiled data from experimental feeding studies in different animal species, diet–apatite spacing in humans can be calculated as $\delta^{13}C_{apatite}=10.1+\delta^{13}C_{diet}$ ‰ (Fernandes *et al.*, 2012).

5.3. Stable oxygen isotopes

The naturally occurring stable isotopes of oxygen are ^{16}O, ^{17}O and ^{18}O. By far the most common is ^{16}O (Brown & Brown, 2011: 86). Of relevance to stable isotope studies in archaeology is the ratio $^{18}O/^{16}O$. Oxygen isotope ratios ($\delta^{18}O$) are measured in relationship to the VSMOW standard (Vienna Standard Mean Ocean Water, Coplen, 1996) and presented in ‰ according to the standard formula:

$$\delta^{18}O = \left(\frac{(^{18}O/^{16}O)_{sample}}{(^{18}O/^{16}O)_{standard}} - 1 \right)$$

As the heavier isotope ^{18}O is less mobile it needs more kinetic energy to evaporate (Dansgaard, 1964). Consequently, the $\delta^{18}O$ of meteoric water ($\delta^{18}O_w$) is dependent on local levels of precipitation, humidity and local temperature and values vary considerably according to latitude, altitude, distance to the sea and local climate. (Dansgaard, 1964, Gat, 1996). Human body water is directly derived from environmental water ingested through liquid intake, and to a lesser degree atmospheric O_2 and food. Oxygen isotope ratios preserved in carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) of bioapatite therefore preserve the local signature of ingested water during tooth and bone formation (e.g. Longinelli, 1984, Luz *et al.*, 1984, Koch *et al.*, 1989). Based on these principles, there are two main applications in archaeological research: the differentiation between local and non-local individuals (e.g. Dupras & Schwarcz, 2001, Mitchell & Millard, 2009, Buzon & Bowen, 2010, Chenery *et al.*, 2010, Groves *et al.*, 2013) and palaeoclimatic inferences (e.g. Iacumin *et al.*, 1996a, White *et al.*, 2004, Touzeau *et al.*, 2013). In Nubian populations oxygen isotopes have been used in several studies to identify potential migrants (White & Schwarcz, 1994: Wadi Halfa (350–1400AD), Buzon & Bowen, 2010: Tombos (1450–1070BC)). Palaeoclimatic issues have been addressed by Iacumin *et al.* (1996a) testing individuals from Kerma (1750–1500BC), while Turner *et al* (2007) used oxygen isotopes to analyse age-related dietary differences in medieval human remains from Kulubnarti (350–1400AD).

The fractionation between environmental water and tissue has been shown to be dependent on body temperature, metabolic rates, water requirements and water storing capacities (Luz & Kolodny, 1985) and have therefore been shown to be species-specific (Bryant & Froelich, 1995). In animals, diet has also been shown to influence oxygen isotope ratios of body tissue (e.g. Bocherens *et al.*, 1996, Kohn *et al.*, 1996, Sponheimer & Lee-Thorp, 1999). Kohn *et al.* (1996) and Sponheimer & Lee-Thorp (1999) generally found browsing and mixed-feeding herbivores to be enriched in $\delta^{18}O$ when compared to grazers, while carnivores were depleted in respect to herbivores. It was suggested that the differences in oxygen isotope ratios between browsing and grazing species may be explained by differences in the ratio of C_3 to C_4 plants in the diet of different species (Sponheimer & Lee-Thorp, 1999). Whether this may also affect humans is still not fully understood (White *et al.*, 2004). Another factor influencing $\delta^{18}O$ in body water is composition and preparation of the diet. Daux *et al.* (2008) have shown significant enrichment in cereals, legumes, meat and fish during cooking because they incorporate large amounts of ^{18}O-enriched water during the process, leading to an increase of 1.1‰ in tooth enamel with respect to drinking water. Ill health may represent another potential source of variation in stable oxygen isotope composition of human tissue. Studies by Epstein & Zeiri (1988) and Heller and co-workers (1994) measuring oxygen isotope ratios in breath found lower fractionation of oxygen in individuals with anaemia. An experimental study using mice confirmed significant depletion of oxygen isotope ratios of bone in mice suffering from sickle cell anaemia (Reitsema & Crews, 2011). In archaeological human remains from the Nubian site of Wadi Halfa (500–1450AD), White et al. (2004) found lower $\delta^{18}O$ values in females suffering from osteopenia but failed to detect any correlation with cribra orbitalia, assumed to be an indicator of chronic anaemia.

$^{18}O/^{16}O$ ratios in phosphate ($\delta^{18}O_P$) and carbonate ($\delta^{18}O_C$) of bioapatite have been shown to be highly correlated and can be related through regression equations (Iacumin *et al.*, 1996b, Chenery *et al.*, 2012). For hot, arid climates the recommended formula for conversion is as follows $\delta^{18}O_P = 1.122*\delta^{18}O_C - 13.73$ (Chenery *et al.*, 2012). Research on archaeological and fossil material has indicated that carbonate is more prone to diagenetic alteration than phosphate (Koch *et al.*, 1990). Thus, isotopic studies have preferentially used oxygen isotope ratios from phosphate (e.g. Iacumin *et al.*, 1996a, Sponheimer & Lee-Thorp, 1999, White *et al.*, 2004, Touzeau *et al.*, 2013). However, this appears to be less problematic in tooth enamel as, due to its density, it has been proven to be less affected by diagenetic contamination than bone (Sponheimer & Lee-Thorp, 1999, and see discussion below).

In order to reconstruct $\delta^{18}O$ values of environmental water several equations have been developed to infer environmental water $\delta^{18}O_W$ from phosphate (e.g. Longinelli, 1984, Luz *et al.*, 1984, Daux *et al.*, 2008) and carbonate (Chenery *et al.*, 2012).

5.4. Tissues used in stable isotope analysis

Stable isotope ratios used in biomolecular studies of diet in the past can be analysed from a variety of tissues. The most common source of stable isotope data in palaeodietary studies in human and animals remains is bone collagen which constitutes the majority of the organic portion of dry bone and comprises approximately 35% carbon and 11–16% nitrogen (Katzenberg, 2008: 415). As bone is a living tissue, collagen undergoes constant remodelling during a life time. The average turnover rate for bone collagen in adults is assumed to be 10 years, thus isotopic values deduced from bone collagen will allow inferences of the average diet over the last 10 years of someone's life (Sealy *et al.*, 1995). However, studies have shown that there is considerable variation in collagen turnover depending on individual age (Hedges *et al.*, 2007) and bone type, with compact bone undergoing slower turnover than thinner, trabecular bone (Sealy *et al.*, 1995). The presence of diseases has also been shown to influence collagen turnover in bone (Katzenberg & Lovell, 1991). The major disadvantage of bone collagen over other isotope sources lies in the fact that it starts degrading immediately after death. The process of collagen degradation is highly complex and its rate is largely dependent on the presence of microorganisms as well physical and chemical properties of the burial environment (e.g. DeNiro, 1985, Collins *et al.*, 1995, Collins *et al.*, 2002). Most notably, water and heat have proven to be detrimental for the preservation of bone collagen (e.g. Von Endt & Ortner, 1984, Nielsen-Marsh *et al.*, 2000). Arid conditions like those found at Amara West have also been shown to be detrimental to collagen preservation (Grupe, 1995).

The second source of stable isotope data in human and animal skeletal remains is hydroxyapatite ($Ca_{10}(PO_4)_6OH_2$) which constitutes the inorganic portion of bone and teeth (Katzenberg, 2008: 416). In contrast to collagen, apatite provides information about the carbon and oxygen composition. The isotopic composition of bone bioapatite again reflects the average diet over the last 10 years in a person's life (Hedges *et al.*, 2007). In contrast, tooth enamel only forms during the first 10–12 years of life depending on tooth type and does not undergo any remodelling, and thus the carbon content of tooth enamel only allows inferences about childhood diet (Hillson, 1996).The use of bioapatite in palaeodietary studies has two major advantages over collagen. It is generally much more resilient to diagenetic degradation than collagen even though there are differences between bioapatitie in bone and teeth (Katzenberg, 2008: 416). Thus, it allows for dietary studies to be applied to poorly preserved bone (e.g. Ambrose & Norr, 1992, Krigbaum, 2003) as well as much older material (e.g. Ungar & Sponheimer, 2011). Moreover, several studies have shown that there are considerable differences in routing of carbon from dietary components (e.g. Lee-Thorp *et al.*, 1989, Ambrose & Norr, 1993, Tieszen & Fagre, 1993, Jim *et al.*, 2004, Kellner & Schoeninger, 2007). While carbon in collagen is only taken up from dietary protein, carbonates present in bioapatite reflect the entire diet, including carbon, from lipids and carbohydrates. Consequently, an increasing number of studies are considering carbon isotope values of both collagen and carbonate in order to gain a more comprehensive understanding of dietary patterns in the past (e.g. Kellner & Schoeninger, 2007, Froehle *et al.*, 2012, Somerville *et al.*, 2013).

Major differences also exist in the resilience of bioapatite between bone and teeth (Katzenberg, 2008: 417). Due to its porosity, bone is generally more susceptible to infiltration of soil chemicals. Therefore, studies have shown bioapatite in bone to be potentially affected by diagenetic effects as well (e.g. Koch *et al.*, 1997, Nielsen-Marsh & Hedges, 2000, Garvie-Lok *et al.*, 2004, Shin & Hedges, 2012). Debate in recent years has also focussed on potential fractionation differences in isotopic composition between bone and teeth (Loftus & Sealy, 2012). Usually assumed to be similar in both tissues, due to similar physiological pathways via which carbon and oxygen are incorporated in both enamel and bone (e.g.Lee-Thorp & Sponheimer, 2003, White *et al.*, 2004, Touzeau *et al.*, 2013), experimental feeding studies on animals have shown significant offsets between the two types of tissue both for carbon and oxygen (Warinner & Tuross, 2009). Warinner & Tuross' (2009) study on modern pigs revealed that enamel is enriched in ^{13}C by as much as 2.6‰ compared to bone. In archaeological human remains, Loftus & Sealy (2012) tested the correlation of $\delta^{13}C$ in apatite from bone and teeth to collagen and found a weaker correlation between bone apatite and collagen than between tooth apatite and collagen. However, the authors attribute their findings to issues of bone preservation and/or pre-treatment during analysis rather than a systematic offset between the two types of tissue.

A possible disadvantage in using apatite from dental enamel for analysis of oxygen stable isotopes may lie in the effect of nursing on oxygen isotope composition. Most permanent teeth start mineralisation during nursing. There has been some debate as to whether nursing, when a large proportion of food and liquid is taken from breast milk, has an effect on oxygen isotope values in teeth. While Wright & Schwarcz (1999) proposed an enrichment through nursing by +0.6‰ and Evans *et al.* (2006) +0.18‰, no such differences were observed by White *et al.* (2004) and Touzeau *et al.* (2013).

After having introduced the background of the bioarchaeological and biomolecular methods used to address investigate health, diet and living conditions at Amara West, the following chapter will detail the current stage of bioarchaeological research in Nubia.

Chapter 6. Bioarchaeological research in Nubia

6.1. Historic developments

6.1.1. The First and Second Archaeological Survey of Nubia

The beginnings of bioarchaeological research on Nubian skeletal collections date back to the early 20th century when the enlargement of the Aswan High Dam stirred one of the first large scale salvage missions, the First Archaeological Survey of Nubia, between 1907 and 1911 (Adams, 1977: 71). The campaigns, directed by British archaeologists Reisner and Firth, led to the discovery of several thousand skeletons and mummified remains from all major periods of Nubian history between the Palaeolithic to the Islamic periods. Pioneering for the early 20th century, the excavators were accompanied by a group of anatomists led by Australian physician Smith to study the human remains in the field. In addition to recording age-at-death, sex and metrical data, a main focus of their analyses were pathological changes on the bones. The resulting corpus of data was comprehensively published by Smith & Jones (1910). These works are still considered a major step in the early development of palaeopathology today (e.g. Armelagos & Mills, 1993), despite criticism about the lack of systematic evaluation of pathological conditions present, the inaccuracy of the diagnoses, and the fact that the researchers were highly selective in only recording some diseases such as tuberculosis and gout while thoroughly ignoring others (Waldron, 2000).

Despite the large number of human remains excavated during the Archaeological Survey of Nubia, only a small fraction survive and are available for study. Smith and his co-workers had bones showing evidence of pathology exported from Nubia (Waldron, 2000), where they were dispersed over several different institutions in the UK. A large sample was donated to the Royal College of Surgeons in London where it was destroyed during bombardment in 1941 (Molleson, 1993). Recently, attempts to locate all of Smith's "donations" are being made by researchers at the University of Manchester and the Natural History Museum of London, both institutions where a small number of Archaeological Survey of Nubia remains are currently stored. Sponsored by the Wellcome Trust, the aim of this joint project is to put together a database of human and animal remains excavated during the Archaeological Survey of Nubia [3].

[3] http://www.knhcentre.manchester.ac.uk/research/nubiaproject/

With the raising of the Aswan Dam, Nubia saw another large scale archaeological salvage campaign, termed the Second Archaeological Survey of Nubia, between 1929 and 1934. The main focus was again on cemeteries, leading to the discovery of 76 sites (Adams, 1977: 76). The human remains were studied by Batrawi and published in a separate report in 1935 (Batrawi, 1935). Contrary to the reports by Smith & Jones (1910), Batrawi focussed largely on biological aspects of the sample populations excavated which he justified by stating that *"With regard to the anatomical variations and pathological conditions, there is little to add to Dr. Wood Jones's lengthy and instructive treatment of them."* (Batrawi, 1935: VII).

In contrast to the excavations carried out during the Archaeological Survey of Nubia, the other archaeological expeditions to Upper and Lower Nubia during the first half of the 20th century contributed little to the study of the human remains. As was usual during the early days of archaeology, human remains received hardly any attention and thus were neither recorded nor curated for future work. Examples include the German excavations of the C-group and New Kingdom cemeteries at Aniba (Steindorff, 1935, 1937) as well as the extensive cemeteries that including the royal tomb complexes of the Kushite rulers at Meroe and el-Kurru excavated by Reisner between 1916 and 1925 (Dunham, 1950).

There are a few exceptions, even though interest in human remains was sketchy at best, as exemplified by a statement of Griffith who directed the Oxford University Excavations at Sanam 1912–13: *"The late Sir Armand Ruffer, who stayed several days with us towards the end of our work, […], and contented himself with taking a few jaws, leg bones, etc. which showed traces of disease or other noticeable conditions."* (Griffith, 1923: 81). Other expeditions were restricted to collecting skulls due to the fact that population affinities were the main research interests at that time (Baker & Judd, 2012). Large scale cemetery excavations were carried out by the Austrian Academy of Science under the direction of Junker in 1911 and 1912 at Toschka, Arminna and el-Kubaniah (Adams, 1977). A sample of skulls excavated during these missions was donated to the Natural History Museum in Vienna where they are curated to the present day (Berner, forthcoming). In a similar manner, only a collection of skulls remain from the extensive excavations at Kerma carried out by Reisner in 1912–1913 (Reisner, 1923), currently held in the Duckworth Collection at the University of Cambridge, England. A sample of skulls was also collected during the excavations carried out by the Egypt Exploration Society at Sesebi (Blackman, 1937) and the data collected from them published by Lisowksi

(1952). However, the whereabouts of these remains is presently unknown (Rose, pers. comm., 2012).

6.1.2. The Aswan High Dam campaigns

With the construction of the Aswan High Dam between 1960 and 1971 and the concurrent inundation of the Nile Valley between Aswan and the 2nd Cataract, Nubia saw another major wave of archaeological expeditions. Teams from 21 countries recorded over 1000 sites, and over a third were excavated (Adams, 1977: 86). In contrast to the foregoing salvage campaigns during the Archaeological Survey of Nubia, a significant number of the skeletal assemblages resulting from the Aswan High Dam campaigns were retained and distributed to museums and university departments all over Europe and the U.S. (see Table 6.1). Most importantly, these include the large collection of human remains from various time periods excavated by the Scandinavian Joint Expedition that included over 1500 individuals (Vagn Nielsen, 1970a), and the Medieval Christian cemeteries of Kulubnarti and Semna South excavated by the Universities of Kentucky and Colorado respectively. It is particularly these collections, recovered during the High Dam campaigns, which form the core of data for the bioarchaeological study of ancient Nubia (e.g. Armelagos, 1969, Van Gerven *et al.*, 1973, Van Gerven *et al.*, 1977, Hrdy, 1978, Van Gerven *et al.*, 1981, Hummert & Van Gerven, 1983, Martin *et al.*, 1984, Van Gerven *et al.*, 1995, Kilgore *et al.*, 1997). This is because of their accessibility, their mostly good state of preservation and completeness, and the large sample size; additionally, there are comparatively good contextual data and documentation available, making their inclusion in studies on Nubian bioarchaeology common even today (e.g. Turner *et al.*, 2007, Hibbs *et al.*, 2011).

After the Aswan High Dam campaigns in the 1960s, archaeological interest in Sudan increased and saw a steadily rising number of archaeological expeditions. Following the flooding of Lower Nubia research moved south into the regions of Upper Nubia, in particular into the Dongola Reach (Kerma, Kawa) and the area around Meroe. Notable cemetery excavations were carried out in the vast Kerma necropolises. These have been carried out by Bonnet (University of Geneva) since the 1970s, by French teams at Soleb, Sai Island, Sedeinga and Missiminia, or by the British Museum/SARS mission at Kawa. Nevertheless, the research output of these later excavations with regard to bioarchaeology is still very limited. Thus, while the bioarchaeology of Lower Nubia is relatively well established, comparatively little is known about the region south of the 2nd Cataract.

6.1.3. The Merowe Dam Archaeological Salvage Project

This research gap could be about to become filled; yet again, in the wake of major dam constructions since the beginning of the 21st century new areas have been affected, this time the Upper Nubian Nile Valley region. The Merowe Dam at the 4th Cataract was constructed between 2004 and 2007, and survey and salvage excavations were carried out from 1996 onwards (Welsby, 2008). Again, these saw a large number of archaeological teams from several different countries. Similar to earlier salvage campaigns, a large number of cemeteries were excavated during these expeditions. Processing of the immense corpus of data and material recovered is now underway, but it will be several years before more comprehensive results will be published. Large skeletal collections dating to the Kerma *ancien* and Medieval Christian periods were recovered within the concession area of the British Museum, where they are now stored and made available for study. Furthermore, the skeletons from the site of al-Ginefab and dating to the Meroitic to Christian period are now curated at Arizona State University (Baker, 2008).

Further dam construction along the Nile is already underway and northern Sudan could face as many as six new dams over the next 20 years. While some are still in the very early stages of planning, the construction of dams at Kajbar, north of the 3rd Cataract and at the 6th Cataract has already begun. A new appeal for archaeologists to carry out salvage excavations in these areas was launched in May 2012.

6.2. Topics in Nubian bioarchaeology

6.2.1. Population history

Traditionally, the main focus in the study of human remains from Nubia has been on population history. This is due to the general nature of the field in the early days of the study of Nubian skeletal remains and – more importantly – in its unique geographic location. The Upper Nile Valley forms a natural corridor between the Mediterranean and the tropical regions of Sub-Saharan Africa, providing the easiest route for travel which may have provided an attractive thoroughfare as early as the Early Upper Palaeolithic. In more recent history, the region's importance as a trade route, along with its wealth in natural resources attracting the attention of its powerful neighbours to the North, would have led to frequent cycles of movement of people and peoples to and from regions (Adams, 1977: 13).

Attempts to explain different periods in Nubian history and changes in material culture by movement of peoples to and from the region, derive from analyses of the vast corpus of archaeological material recovered during the First and Second Archaeological Surveys of Nubia. This diffusionist view on Nubian cultural history was strongly supported by the works of the anatomists studying the remains excavated during these expeditions. Following the influential works of Morton who postulated an "Upper Nile Valley" type with predominantly Negroid features, and a "Lower Nile Valley" type lacking these features, researchers used craniometric analyses in order to distinguished different groups associated with each cultural phase and attributed them to different "racial" types or mixtures thereof (Smith & Jones, 1910, Batrawi, 1935, 1945, 1946). The interest in "racial" classification and population history continued to be the major focus of most studies conducted on Nubian human remains, based on osteometric analysis (Mukherjee *et al.*, 1955, e.g. Ehgartner, 1962, Vagn Nielsen, 1970a, Strouhal, 1973, Billy, 1981, Billy & Chamla, 1981, Simon, 1989, Buzon, 2006a) and to a lesser extent on cranial and dental non-metric traits (e.g. Greene, 1966, Johnson & Lovell, 1995, Irish, 2005, Irish & Konigsberg, 2007), with this trend continuing to the present day.

Despite doubts about models of population discontinuity having already been raised by Batrawi (Batrawi, 1945, 1946), only in the aftermath of the Nubian High Dam campaigns did they became more systematically challenged by archaeologists (e.g. Adams, 1968) and bioarchaeologists alike (e.g. Greene, 1966, Vagn Nielsen, 1970a, Van Gerven *et al.*, 1973). An alternative explanation for the observed changes in cranial morphology was first proposed by Carlson and co-workers (Van Gerven et al., 1973, Carlson, 1976, Carlson & Van Gerven, 1977, Van Gerven et al., 1977). They attributed the apparent differences between populations noted by earlier researchers to changes in masticatory function due to changing subsistence strategies over time. According to their model, rather than citing population discontinuity to be the cause, they suggested that the shift to softer food sources led to a reduction in mechanical loading of the cranio–facial muscles which gradually resulted in cranial and facial morphological changes. Since then, the evolutionary model of Nubian population history has been supported by a considerable number of bioarchaeological studies, most concentrating on dental morphology, and all have argued for a relatively homogenous population from at least the Neolithic period onwards (e.g. Small, 1981, Calcagno, 1986, Irish & Turner, 1990, Turner & Markowitz, 1990, Larsen, 1997: 312, Irish, 2005).

Different conclusions have been derived from archaeogenetic research. The data of Krings *et al.* (1999) that used mtDNA from 300 modern and ancient Egyptian and Nubian samples showed that there has been both north-south as well as south-north migration along the Nile Valley within the last 5000 years, the former occurring earlier than the latter. However, they acknowledge that in order to clarify when these migrations occurred, or to correlate them with known historical events such as the colonisation of Nubia, more analysis on ancient samples is required. A certain degree of variation was also detected by Keita & Boyce (2005) when analysing variations of Y chromosome haplotypes within the Nile Valley region, even though again their results are not conclusive enough to reconstruct population history. However, one of the main problems inhibiting biomolecular research in Nubian bioarchaeology is the detrimental effect of the hot arid climate on preservation of DNA (Krings *et al.*, 1999).

The interest in population migration history has recently been revisited, fuelled by the introduction of new scientific research methods such as the analysis of stable strontium and oxygen isotope ratios to explore origin and mobility (Buzon *et al.*, 2007). Unfortunately, however, the Nile Valley region poses many potential problems for strontium/oxygen studies because of the very complex nature of the geology (Montgomery, pers. comm., 2011). Thus, the interpretation of isotopic data may not provide clear conclusions about the population history of Nubia, at least at this time.

6.2.2. Studies in palaeopathology and population health

Despite the large body of available skeletal and mummified human remains, the number of systematic bioarchaeological studies addressing questions about health and associated general living conditions in ancient Nubia is rather limited. The earliest palaeopathological reports again derive from the studies conducted during the First Archaeological Survey of Nubia (Smith & Jones, 1910). Their works were pioneering in palaeopathology in general, and their importance and influence for the development of the field stands without question (see above).

Despite the early start, throughout most of the 20th century reports on pathological changes were either confined to a few pages at the end of skeletal reports, usually mentioning a few interesting observations but failing to provide any systematic, population-based appraisals (Vagn Nielsen, 1970a, Dastugue, 1976, 1981, Canci, 2006), or published case-studies. The first population-based study of disease patterning in ancient Nubia was carried out by Armelagos (1969), analysing disease patterns in the Wadi Halfa region in Lower Nubia from the Meriotic, X-group and Christian period. Since then a growing body of works has focused on aspects of changes in health and disease patterns in relation to socioeconomic or cultural changes (e.g. Van Gerven *et al.*, 1981, Hummert & Van Gerven, 1983, Martin *et al.*, 1984, Van Gerven *et al.*, 1995). These studies have employed a wide range of different health indicators such as skeletal growth, childhood mortality, dental disease (Beckett & Lovell, 1994) and general stress markers (Buzon, 2006b, Buzon & Richman, 2007, Buzon & Judd, 2008).

In addition, the presence of a number of specific infectious and parasitic conditions has been established on the basis of skeletal and mummified remains. Tuberculosis, already noted by Smith & Jones, is attested through skeletal remains from around 3000BC onwards (Roberts & Buikstra, 2003: 167), and Zink *et al.* (2006) have found evidence of leishmaniasis-DNA in Christian mummies from Wadi Halfa. However, based on the finding of leishmaniasis-DNA in Middle Kingdom remains at Thebes in Egypt, they argue that the disease may have been present in Nubia much earlier and that sub-Saharan Sudan seems to be the most likely origin. Mummified remains from the same skeletal assemblage also provided the earliest known evidence for *Schistosomiasis mansoni* which, until then, had been assumed to be a fairly recent phenomenon in Nubia (Hibbs et al., 2011). The second form of this parasitic disease, *S. haematobium* had already been detected in mummified remains from Sai Island dating to the *Kerma ancien* period (Bouchet *et al.*, 2003). Another major research topic in Nubian palaeopathology has been trauma, both in relation to occupational hazards but, more importantly, to warfare and interpersonal violence (e.g. Filer, 1992, Kilgore *et al.*, 1997, Alvrus, 1999, Judd, 2006, Buzon & Richman, 2007). This has been of particular interest with regard to colonisation strategies and postulated population movements to and from the region.

However, despite the abundance of available well preserved skeletal collections (see Table 6.1 for an overview) and the long history of bioarchaeological research in Nubia, knowledge about health, living conditions and disease patterns over the course of history is sketchy at best. Only from the Meroitic until the late medieval Christian period is the situation better as the number of well documented and readily accessible skeletal collections is far greater. As for the earlier periods of Nubian history, a large number of human remains were irretrievably lost due to a lack of emphasis on skeletal remains, and attention to ensuring their preservation and accessibility, by archaeologists in the foregoing century.

6.3. Bioarchaeological perspectives on Egyptian colonialism in Nubia

Despite the considerable number of excavated cemeteries and settlements dating to the time periods of Egyptian conquests and colonial control over Nubia, bioarchaeological questions have only very rarely been addressed. Several reasons account for this lack of research. As is a common problem in bioarchaeological research in Nubia in general, the majority of sites dating to the time periods of Egyptian control over Nubia were excavated during the first half of the 20th century, when archaeologists only had very limited interest in human remains. Thus, for a large number of excavated cemeteries, the only existing record of skeletons was a brief mention in the excavation reports and – at best – a photograph. This is well exemplified by the excavations carried out by the EES at Amara West (Spencer, 2002), where skeletal elements were simply left behind in the graves or discarded on the surface. In a similar manner, nothing remains of the skeletons excavated by Steindorff in the vast necropolis at Aniba, Lower Nubia's capital during the 18th Dynasty (Steindorff, 1937), and no human remains were recorded or analysed from New Kingdom and post-New Kingdom cemeteries associated with the Pharaonic settlement at Sai, excavated by the French mission in the 1970s (Minault & Thill, 1974).

Other sites, particularly those that were excavated during and after the Aswan High Dam campaigns in the 1960s, saw more emphasis on the study and preservation of the human remains even though again the majority of collections are confined to skull samples. As for the Lower Nubian sites, 157 skulls from the New Kingdom cemetery at Shellal (Cemetery 7) were collected during the excavations of the First Archaeological Survey of Nubia. The sample is currently held in the Duckworth Laboratory at the University of Cambridge and is frequently included in bioarchaeological studies of Nubia (e.g. Irish, 2005, Buzon, 2006b). At the 18th Dynasty pharaonic town at Sesebi, skulls collected during the EES excavations in the late 1930s were donated to the University of Birmingham where they were studied and published by F. P. Lisowski (Lisowski, 1952). Most notably, Lisowski reports the finding of an individual who had been trepanned (Lisowski, 1959), a diagnosis that is disputed today but not possible to confirm since the whereabouts of the skulls are unknown.

Another sample of skulls comes from the necropolis at Soleb, Amara West's predecessor as capital of Upper Nubia during the 18th Dynasty; this consists of 32 skulls and several isolated post-cranial elements that were kept and donated to the Musée de l'Homme in Paris for study (Schiff Giorgini, 1971: 9–10). The skulls were later analysed by Billy and Chamla (1981), focussing exclusively on population history as inferred through metrical analysis. A report on the pathological findings, including two skulls showing what was interpreted as evidence of trephination, was published by Dastague (1981). However, the sample appears to be chronologically heterogeneous as the New Kingdom graves were re-used in the Meroitic period (Schiff Giorgini, 1971: 9).

A more complete collection of New Kingdom human remains derives from the salvage excavations during the High Dam campaigns in the 1960s in Lower Nubia, most notably during those carried out by the Scandinavian Joint Expedition. The large number of human remains which were originally studied by Vagn Nielsen (1970a) also includes 92 skeletons from 10 different Pharaonic sites which are currently held at the Biological Anthropology Laboratory in Copenhagen, Denmark. The most comprehensive sample of human remains dating to the time period of New Kingdom control over Nubia comes from the cemeteries associated with the Egyptian settlement at Tombos at the 3rd Cataract which have been excavated by Smith since 1993 (Smith, 2003). The human remains, dating both to the New Kingdom and post-New Kingdom period, are exported to Purdue University, Michigan after each season for further analysis (see below).

The problems associated with having archaeological evidence for settlement of Upper Nubia during the time period after the end of Pharaonic control are addressed elsewhere (see Section 2.3.5). To date there are only a small number of sites, in addition to Amara West (see Section 6.1.1), where there is tentative evidence for occupation during the 10th and 9th centuries, none of which have human remains preserved. At Hillat el-Arab (Vincentelli, 2006) the skeletal remains were reported to be in such a poor condition and heavily disturbed that very little information could be drawn from the analysis (Canci, 2006). The same problem had apparently been faced by the French mission excavating the post-New Kingdom and early Napatan necropolis at Missiminia on the south bank of the Nile opposite Amara West; because of their poor condition the human remains were left in the ground and not recorded at all (Vila, 1980).

Following trends in research interests in Nubian bioarchaeology in general, most studies on human remains dating to the period of the New Kingdom occupation of

Nubia have focused on population history. Primarily based on significant changes in funerary culture in Lower Nubia at the beginning of the New Kingdom period, it was assumed that the colonisation of Nubia involved large scale migration of Egyptians to Nubia. Thus, bioarchaeologists tried to test whether these migrants could be identified on the basis of cranial (e.g. Smith & Jones, 1910, Batrawi, 1935, 1945, 1946, Vagn Nielsen, 1970a) or dental characteristics (Irish, 2005). Large-scale movement of Egyptians to Nubia based on osteological observations was first postulated by Smith & Wood Jones (1910). Later on, Batrawi detected similarities between the Pharaonic inhabitants in Lower Nubia and the Kerma people, which he tried to explain by an influx of Kerma people from the south during the Second Intermediate Period. Even though Vagn Nielsen (1970a: 86–87) made similar observations in his study of the human remains excavated by the Scandinavian Joint Expedition in the 1960s, he nevertheless claimed that the Pharaonic series represented immigrants from Egypt.

The only systematic studies addressing the impact of Egyptian colonialism on health and living conditions were carried out on the human remains from the New Kingdom cemetery at Tombos (Smith, 2003, Buzon, 2006b, a, Buzon & Richman, 2007, Buzon & Bombak, 2010, Schrader, 2010, 2012). Buzon carried out an analysis of selected non-specific stress markers (cribra orbitalia, enamel hypoplasias, femur length and periostitis) observed in the Tombos individuals and compared them with broadly contemporary skeletal assemblages from Lower Nubia and Egypt proper. Her findings revealed relatively low frequencies for all those conditions. Furthermore there were no marked differences between Tombos and the comparative sites (Buzon, 2006b). Nevertheless, the sample was slightly problematic as it pooled individuals from the New Kingdom and post-New Kingdom period together; sub-adults seemed also to be underrepresented and a large number of individuals appeared to have come from commingled contexts (Schrader, 2010: 94). Femur lengths of the Tombos individuals were relatively short in comparison to other samples but unfortunately the small sample size (12 females, 7 males) did not allow for conclusions. A study of fracture patterns suggested a decline in trauma frequency when compared to Kerma, which was attributed to shifting Egyptian policies reflected in a violent Middle Kingdom military invasion to peaceful colonial policies based on diplomacy during the New Kingdom (Buzon & Richman, 2007).

Chapter 6 provided a discussion of current stage of bioarchaeological research. In the following chapter the assemblage of human remains forming the basis of the bioarchaeological study, as well as the analytical methods and recording procedures, will be introduced.

Site name	**Dating**	**Sample size**	**Excavated by**	**Years**	**Current location**	**Skeletal report**	**Key research published**
Kerma	2500–1500BC	307	G. A. Reisner	1912–1917	University of Cambridge (Duckworth Collection), England	-	e.g. Filer 1992; Judd 2002, 2004, 2006; Buzon 2006
Kerma	2500–1500BC	?	C. Bonnet	1974–	University of Geneva, Switzerland	de Carvalho, 2002 , various smaller reports by Simon	e.g. Simon 1989, Thompson *et al* 2008
Mirgissa	Middle Kingdom, Second Intermediate	354 skulls, 278 mandibles	J. Vercoutteur	1963–64	France	Billy 1976, Dastague 1976	-
Sesebi	NK	33	A. Blackman	1937	?	Lisoski 1952, 1959	-
Shellal	NK	157	Archaeological Survey of Nubia	1907	University of Cambridge (Duckworth Collection), England	Smith 1908, Smith & Jones 1910	Buzon 2006
Tombos	NK–Napatan	>100	S. T. Smith	since 2000	Purdue University, Michigan, USA	-	Buzon 2006, Buzon & Richman 2007
Soleb	NK, Meroitic?	32 (skulls)	M. Schiff-Giorgini	1970	Musée de l'Homme, Paris, France	Billy & Chamla 1981	Irish 2005
Scandinavian Joint Expedition	A-group – Christian	1546	SJE	1960–1970	Biological Anthropology Laboratory, University of Copenhagen, Denmark	Vagn Nielsen 1970	e.g. Johnson & Lovell 1995, Buzon 2006
Missiminia	Meroitic – Medieval Christan	333 (skulls)	A. Vila	1974	Centre d'Antropologie, Université Paul Sabatier, Toulou,e France	Billy 1985	Crubézy *et al.* 1999
Gabati	Meroitic – Medieval Christian	>100	D. Welsby	1994–1995	British Museum, London	Judd 2013	-
Semna South	Meriotic – Medieval	592	Oriental Institute of	1966–1968	Arizona State University, USA	Field notes by Zabkar & Smith,	Hrdy 1978 Alvrus 1999

	Christan		Chicago				
Shellal	Medieval Christian		Archaeological Survey of Nubia	1907	University of Cambridge (Duckworth Collection), England	Smith & Jones 1910	
Kulubnarti	Medieval	406	W. Y. Adams	1979	University of Colorado, Boulder, USA	-	e.g. Armelagos 1969, Van Gerven *et al* 1981, Kilgore 1997, Hibbs et al. 2011
Mis Island	Medieval	>500	D. Welsby	2005–2006	British Museum, London University of Michigan, USA	Antoine in prep. Sohler 2011	

Table 6.1 List of major skeletal assamblages from Upper and Lower Nubia

Chapter 7. Materials and Methods

In the first section of the following chapter, the collection of skeletal human remains forming the basis of this study will be described. The second section introduced the methodology employed in this study in order to address the outlined research questions.

7.1. Materials

7.1.1. General overview

		New Kingdom		Post-New Kingdom		Total		Total individuals
		Sub-adult	Adult	Sub-adult	Adult	Sub-adult	Adult	
Cemetery C	**n**	1	27	30	58	31	85	116
	%	0.6	15.0	16.7	32.2	17.2	47.2	64.4
Cemetery D	**n**	0	8	21	35	21	43	64
	%	-	4.4	11.7	19.4	11.7	23.9	35.6
Total	**n**	**1**	**35**	**51**	**93**	**52**	**128**	**180**

Table 7.1 Overview over number of individuals analysed in this study

This study includes 129 adult and 51 sub-adult individuals excavated from Cemeteries C and D of Amara West during the excavation seasons 2009, 2010, 2011, 2012 and 2013 (see Table 7.1). While the New Kingdom sample (c. 1300–1070BC) comprised 36 individuals, 144 individuals could be dated to the post-NK period (c. 1070–800BC).

7.1.1. Preservation of the human remains

		New Kingdom chamber		Post-New Kingdom chamber		Post New Kingdom niche	
		Single	Multiple	Single	Multiple	Single	Multiple
Articulated	**n**	0	24	0	49	8	3
	%	-	66.7	-	55.7	29.6	10.3
Disarticulated	**n**	0	12	0	39	19	26
	%	-	33.3	-	44.3	70.4	89.7
Total	**n**	**0**	**36**	**0**	**88**	**27**	**29**

Table 7.2 Degree of articulation of individuals analysed in this study

Due to funerary customs (see Chapter 3) the assemblage comprises both complete individuals but also a large number of individuals recovered from commingled contexts (see Table 7.2). Depending on the number of individuals present in burial contexts as well as general bone preservation partial re-assembling of individuals was possible in most cases. However, smaller skeletal elements (hands, feet, ribs or vertebrae) often could not be securely assigned to an individual, limiting their value for palaeopathological research. Excluded from the systematic analysis were individuals from commingled contexts if they were not considered complete enough to meet the criteria and research aims outlined above. The assemblage analysed in this study only comprised skeletal remains. Soft tissue preservation was restricted to small fragments (see Figure 7.1) which could be used for further analysis in due course but were not included in this study.

Figure 7.1 Mummified brain of Sk244-4 (New Kingdom)

Preservation of the human remains was very varied across the site with major differences between tomb types, parts of the site, as well as different individuals within burial chambers. Generally, preservation was much better for graves carved into silt than for rock-cut tombs, owing to the high salt content of the schist bedrock resulting in higher acidity, known to have a detrimental effect on bone preservation (Nielsen-Marsh *et al.*, 2000). Additional damage was caused by termites and/or dermatoid beetles (see Figure 7.2).

Figure 7.2 Postmortem damage: deteriorated teeth (G244, Cemetery C), termite damage in bone (G234, Cemetery C)

Due to the support of the National Corporation of Antiquities and Museums, Sudan, the entire assemblage was donated to the British Museum and is now permanently curated in the Department of Ancient Egypt and Sudan at the British Museum. All analyses were caried out in the Institute for Bioarchaeology Laboratory at the museum. The original recording forms for this study are also archived there.

7.2. Methods

7.2.1. Introductory remarks

The following section contains a discussion of the bioarchaeological and palaeopathological methods of analysis and recording applied in this study. The methods were chosen in order to fulfil the requirements necessary to address the research questions outlined in Chapter 1 of this study. In order to comply with common standards applied within the field of bioarchaeology and allow for comparability with other studies the analytical methods were chosen following Buikstra & Ubelaker's (1994) "Standards for Data Collection in Human Remains" as well as the recommendations of the British Association of Biological Anthropology and Osteoarchaeology (BABAO) (Brickley & McKinley, 2004), which are standard in bioarchaeological studies in the UK.

7.2.2. Establishing a skeletal inventory

Establishing a detailed inventory is the first step in recording human remains and is crucial for any further analysis in order to achieve statistically relevant results with regard to true frequencies of traits or changes (Buikstra & Ubelaker, 1994: 6). Thus, each skeleton was recorded for completeness and overall preservation of the bones (details are outlined in Sections 7.2.3 and 7.2.4). The inventory system was chosen in accordance with the scheme used at the British Museum, London, where the human remains are curated; this was because all the data collected will be ultimately integrated into the museum's database. The database was originally developed by Redfern in 2008 at the British Museum, based on the recommendations of Buikstra & Ubelaker (1994). Further enhancements and recording forms were made by the current curator of human remains in 2011. However, for analytical reasons some adjustments had to be made. A full inventory form is attached in Appendix I.

7.2.3. Complete skeletons

7.2.3.i. Preservation

Preservation of the skeletal elements was recorded using two different schemes, assessing overall preservation and surface preservation separately. The categories used were defined by Redfern (2008, Antoine, pers. comm., 2010) for recording of human remains held in the British Museum and are given in Table 7.3 and 7.2 below.

1. Class 1: 0% of sound cortical surface
2. Class 2: 1–24% of sound cortical surface
3. Class 3: 25–49% of sound cortical surface
4. Class 4: 50–74% of sound cortical surface
5. Class 5: 75–99% of sound cortical surface
6. Class 6: 100% cortical surface completely sound

Table 7.3 Surface preservation

1. Excellent: solid bone, no or little breakage or erosion
2. Good: some breakage
3. Fair: some pieces of bone missing
4. Poor: most elements broken with pieces missing, cracks, splintering and bone surface is rough
5. Fragments: all bones are friable, splintered or very fragmentary, extreme weathering, little identification possible
6. Other

Table 7.4 Overall preservation

7.2.3.ii. Completeness

Completeness was recorded according to Buikstra & Ubelaker (1994: 6), scoring presence and completeness according to the following scheme:

0 absent
1 < 25%
2 25–75%
3 >75%

Skeletal elements were further divided into areas according to the scheme outlined by Brickley (2004a, Brickley & McKinley, 2004: 60–61) in the standards of the BABAO (see Table 7.5). Enhancements were made with regard to recording of vertebral body and neural arches were scored individually. This was deemed necessary to enable more detailed analysis of pathological changes.

Area	Bone elements scored separately according to the system	Other
Skull	all elements scored separately	
Long bones and Clavicles	proximal joint/ epiphysis proximal third middle third distal third distal joint/ epiphysis	
Scapula	scapula acromion glenoid cavity	
Ribs (1, 2, 11, 12)	head neck shaft	Ribs 3 – 10: counts of heads, shafts and sternal ends
Vertebrae	body neural arch	
Pelvis	ilium ischium pubis auricular surface pubic symphysis	
Hands/ Feet	individual carpals/ -tarsals individual metacarpals/ -tarsals	metacarpals/ -tarsals: if unsided count of present elements recorded phalanges: counts of present elements recorded (proximal, mid and distal)

Table 7.5 Inventory scheme for skeletal elements

In addition, a visual inventory was created for each individual using idealised skeleton drawings developed by Michael Schultz (see Appendix I). Drawings for different developmental stages of age were used.

7.2.4. Commingled remains

A large proportion of the human remains at Amara West come from commingled contexts due to the fact that most graves were continuously re-used for burial and also looted in antiquity. The degree to which these remains could be included in this study, and individual skeletons re-assembled, was highly variable, depending on general bone preservation, age of the individuals, number of individuals buried in the tomb, as well as timing and reason for looting. The best results were achieved in cases where the chambers only held a small number of individuals, and commingling occurred at a stage when enough soft tissue was preserved to allow for some articulations to remain in anatomical position (e.g. G305-western chamber). In the worst cases, individuals were entirely disarticulated, heavily eroded and deriving from a large number of different burials (e.g. G201-eastern chamber).

Recording and analysing commingled remains is still considered a very difficult undertaking, even though the last decades has seen a large number of methodological advances, mainly driven by the needs arising from forensic anthropological work in human rights contexts and in cases of mass disaster. However, as Ubelaker (2008: 1) states *"…, there is no "cookbook" approach to commingling issues. Practitioners must be aware of the myriad of techniques available and craft a case-specific protocol to address the specific problems at hand.*"

7.2.4.i. Inventory

With regard to preservation, commingled assemblages were scored according to the same scheme as the complete remains (see Table 7.3, 7.4). Each identifiable element was recorded. Individuals that could be securely re-assembled to a certain degree were assigned a skeleton number and included in the palaeopathological analysis. Identifiable skeletal elements which could not be assigned to an individual were registered and assigned numbers seperately for each context. They were described with regard to preservation and presence of evidence of pathological changes. Inclusion in the overall systematic analysis of the human remains from Amara West was only undertaken in analyses where parameters that are impossible to infer for the commingled remains, such as sex, age category, laterality and presence of further skeletal elements, were considered an imperative condition of validity.

7.2.4.ii. Re-assembling and sorting of individuals

Sorting of commingled human remains followed the procedures first outlined by Snow (1948) and further enhanced by Adams & Byrd (2006). Skeletal elements were arranged anatomically and sorted with regard to side, robusticity and age-specific criteria. Elements that were recovered in anatomical association remained in groups. In order to facilitate segregation, conjoining of broken elements was attempted to a certain degree, largely depending on the state of preservation, degree of fragmentation and number of individuals. However, as the application of adhesives is generally considered problematic as they may hinder further biochemical analysis (Richards, 2004), no adhesives were used to stick bone fragments together.

In order to re-assemble individual skeletons visual pair-matching was used as a first step (a technique that has been shown to provide good results if carried out by experienced researchers) on comingled bones with a reasonable state of preservation, completeness and representing a low number of individuals (Adams & Byrd, 2006). The matching criteria used involved size, robusticity, the occurrence of muscle markings and age-related changes. In several cases, taphonomic criteria (colour, general preservation) were also tentatively considered. As a next step, bones elements that made up joints were matched, with "high" and "moderate" confidence, as outlined by Adams & Byrd (2006: 66).

In tombs with low numbers of interments and good preservation, relatively good results could be achieved. One of the limiting factors in complete re-assembling of individual skeletons was the fact that often elements were lost during re-use and looting of the graves. Isolated human remains scattered on the surface is quite a common sight at Amara West, with the bones usually experiencing heavy taphonomic alterations due to potentially three thousand years of exposure to sun, sand and wind; it is therefore impossible to associate them back to individual tombs and this is even less possible with different individuals in one tomb. In most cases not all elements could be directly matched with individual skeletons, especially with regard to the ribs, spine and small bones of the hands and feet. In these cases, tentative matches were still made based on the criteria of size, robusticity, age-related and pathological features, even though it is acknowledged that this is considered problematic and can be misleading (Adams & Byrd, 2006).

Reassembled individuals were treated and recorded in the same way as complete individuals and included in all further analysis if the relevant elements were present. If skeletal elements were re-associated from different contexts, this was indicated in different colours on the visual recording form and the skeletal elements packed separately. All elements that could not be assigned to an individual skeleton were assigned numbers and recorded separately.

7.2.4.iii. Minimum number of individuals (MNI)

An MNI for all multiple burial chambers was calculated based on the most commonly occurring skeletal element or section of an element (e.g. femoral head, left mandibular ramus) as is standard in bioarchaeological studies (McKinley, 2004). Calculations considered all skeletal elements present per grave, including articulated individuals as well as commingled remains.

7.2.5. Dental inventory

A detailed dental inventory was established for every preserved tooth in the dentitions, both for complete and for commingled remains. Each tooth position was examined and recorded separately according to common standards (Buikstra & Ubelaker, 1994: 49) and classified into one of the categories given in Table 7.6.

	present
/	lost ante-mortem
x	lost post-mortem
B	broken post-mortem
R	only root present
--	jaw not present
A	congenital absence
E	erupting but not in occlusion
NE	not erupted

Table 7.6 Categories used in dental inventory

7.2.6. Estimating Sex

The estimation of the biological sex of an individual is another demographic parameter crucial to the systematic analysis of skeletal assemblages. On a morphological level, sex estimation in human remains is usually carried out by examining features on the skull and pelvis that are expressed differently in males and females, with features on the pelvis taking priority for sex estimation (Mays & Cox, 2000). Sexual dimorphism in the pelvis mainly reflects evolutionary and functional modifications and is related to bipedal locomotion and childbearing and childbirth (Mays & Cox, 2000). In contrast, dimorphic expression of features in the skull mainly reflects differences in muscle mass both during development and after maturity. Hence, sex differences in the skull can be obscured by cultural practices and physical activity and are therefore considered a lot less reliable in assessing biological sex than those in the pelvis (Chamberlain, 2006: 95–96).

Despite a generally high degree of accuracy in sexing adult human remains, sex-related features in males and females vary along a continuum, and thus a distinction may not always be clear-cut. Additional limitations in the reliability of osteological sex estimation relate to sexually dimorphic features, with the exception of some pelvic traits, that can vary considerably between populations (Mays & Cox, 2000). Some morphological traits both in the skull and pelvis also appear to be age-related, and thus the shape of features, and how they change and are expressed over the course of an individual's life, is important to consider (Brickley, 2004b). It is therefore necessary to always consider multiple features in the pelvis and skull before ascribing sex to an individual skeleton. Moreover, in order to account for the effect of possible population-specific differences, the general variation within a population should be considered before reaching conclusions (Buikstra & Ubelaker, 1994: 16).

Problems in establishing a valid palaeodemographic profile of an archaeological population can also be posed by the fact that there seem to be sex-related differences in preservation. Research on documented historical skeletal collections has shown that female skeletons, especially those of older females, tend to preserve less well than males which potentially leads to a bias in the archaeological record (Walker, 1985).

In this study, sexing of the adult skeletons was achieved through visual assessment of morphological features of the skull and pelvis following the catalogue of traits outlined by Acsádi & Nemeskéri (1970). Eleven traits were observed in the skull, most importantly the glabella, supra-orbital ridges and forehead profile, mastoid process and ridge, occipital protuberance, nuchal crest, and frontal and parietal protuberances. In addition, five morphological features were examined comprising the mental eminence as well as the angulation and shape of the mandibular ramus. A further 12 features were examined in the os coxae and sacrum, including the shape of the sciatic notch, sub-pubic angle, arc composé, overall shape of the os coxae, as well as the size, shape and robusticity of the corpus ossis ischii, crista illiaca and foramen obturatum. Absence or presence of a pre-auricular sulcus was also recorded even though it has been argued that this trait is related to shape and size of the pelvis rather than to individual sex (Mays & Cox, 2000).Traits on the sacrum included overall shape and size of the superior aspect of S1, as well as the auricular surface. An additional method to estimate biological sex applied in this study considered morphologic features in the pubic bone (Phenice, 1969). These traits, comprising the ventral arc, sub-pubic concavity and sub-pubic angle have been found to provide a high degree of accuracy in most samples when applied to individuals with known sex (Sutherland & Suchey, 1991), even though there do seem to be population-specific variations (Chamberlain, 2006: 97).

Each indicator was scored on a 5-stage scale as: -2 – female, -1 – probable female, 0 – unknown, +1 – probable male, +2 – male. Sex was assigned on the basis of a composite average value of all traits available, though more importance was given to those that are considered more reliable, as outlined by Ascádi & Nemeskéri (1970). For the full list of recorded traits and values see Table 7.7.

Skull	Mandible	Pelvis	Robusticity
Glabella	Appearance	Sulcus praeauricularis	Humerus
Arcus superciliaris	Mentum	Incisura ischiadica major	Femur
Tubera frontalia and parietalia	Angulus	Angulus pubis	
Inclinatio frontalis	Margo inferior	Arc composé	
Processus mastoideus	Angle	Os coxae	
Relief of planum nuchale		Foramen obturatum	
Protuberantia occipitalis externa		Corpus ossis ischii	
Processus zygomaticus		Crista iliaca	
Os zygomaticum		Fossa iliaca	
Crista supramastoidea		Pelvis major	
Margo supraorbitalis		Auricular area	
		Sacrum	

Table 7.7 Morphologic traits used in sex determination

As sexually dimorphic features in the skeleton only develop during and after puberty, estimating sex in immature individuals is still considered to be a major problem (Chamberlain, 2006: 93). Although a number of methods have been suggested, including metrical analysis of tooth crowns and morphological features of the pelvis and skull (e. g. De Vito & Saunders, 1990, Schutkowski, 1993, Holcomb & Konigsberg, 1995), none of them have proven to provide acceptable levels of accuracy (Chamberlain, 2006: 94). Thus, to date, the only method to accurately establish sex in sub-adults that is generally accepted in bioarchaeology remains the analysis of DNA (Faerman *et al.*, 1998, Mays & Faerman, 2001, Brickley, 2004b). However, the application of aDNA analysis in archaeological studies is still considered problematic (e.g. Brown, 2000, Stone, 2008, Roberts, 2009: 209–210). In order to guarantee valid results excavation and handling of samples has to follow strict protocols to avoid contamination with recent DNA (Richards, 2004, Roberts & Ingham, 2008, Roberts, 2009: 210). However, such conditions are often not easily met, especially not in the context of fieldwork at sites such as Amara West. Another main issue, particularly prevalent in studying human remains from arid climates is the negative effect of heat on aDNA and several studies have shown that the chances for survival of DNA under desert environmental conditions are not very good (Zink & Nerlich, 2003, Gilbert *et al.*, 2005). Additional problems include the fact that DNA analysis is still a very expensive undertaking and most researchers neither have the financial resources nor access to appropriate facilities. Consequently, sex estimation of the immature individuals was not attempted in this study.

7.2.7. Age-at-death

Sub adult age-at-death	References
dental development	Smith 1991
skeletal maturation	
- long bone length	Scheuer & Black 2000, Maresh
- epiphyseal closure	Scheuer & Black 2000
Adult age-at-death	
final stages of maturation	Cox 2000; Scheuer & Black 2000
dental attrition	Miles 1963; Ubelaker 1989
pubic symphysis	Brooks & Suchey 1990
auricular surface	Lovejoy 1985

Table 7.8 Summary of age-estimation methods applied in this study

7.2.7.i. General remarks

Age-at-death is one of the most important and influential parameters in the study of human remains and is crucial to the analysis and understanding of health, and related living conditions, of past human populations (Cox, 2000). However, estimating age at death in adult skeletal remains is also one of the most problematic analytical procedures in osteological research because the human aging process itself is not a regular, straightforward process, influenced by a large number of genetic and environmental variables (O'Connell, 2004, Chamberlain, 2006: 105) which are usually unknown to the archaeologist. Thus, the value and accuracy of age estimation methods currently available for the study of skeletal remains continues to be subject to much debate in the bioarchaeological literature (e.g. Saunders *et al.*, 1992, Cox, 2000, Wittwer-Backofen *et al.*, 2008). Since the early days of bioarchaeological research a large number of different morphological and histological methods have been developed (Kemkes-Krottenthaler, 2002). Considering a wide range of different skeletal features, mainly on the skull and pelvis, common to all attempts has been the desire to estimate age-at-death as accurately as possible so that a more refined insight can be generated into mortality and morbidity patterns in the past. Unfortunately, however, estimating age-at-death in skeletal remains has also proved to be one of the most difficult and error-prone types of analysis in bioarchaeological studies (Chamberlain, 2006: 105).

While methods applied to ageing sub-adult skeletons consider growth-related changes in bones and teeth, adult ageing methods mainly depend on degenerative changes related to wear and tear on bones, joints and teeth that naturally occur during a person's life time (Chamberlain, 2006: 105). However, ageing is far from being a homogenous process. Both growth and degeneration-related changes are highly dependent on and influenced by a wide range of intrinsic (e.g. genetic) and extrinsic factors such as occupation, health status and nutrition which are impossible to control for in an archaeological context (Cox, 2000, Chamberlain, 2006: 105). Therefore, while age at death can be relatively accurately estimated in younger individuals, it is increasingly difficult once skeletal maturation is complete (Cox, 2000). Moreover, the fact that progression rates between chronological and physiological age may start to diverge considerably with increasing age, estimating age in older adults is still considered a major problem. To date, no method has been developed for skeletal remains that securely identifies individuals over 50 years of age, possibly leading to a significant underrepresentation of old adults in the archaeological record (Kemkes-Krottenthaler, 2002).

Another main issue concerns the representative nature of reference skeletal samples on which ageing methods are devised. The techniques available in bioarchaeological studies to date are either developed on archaeological assemblages which are usually of unknown age-at-death and therefore already come with an inherent methodological error, or on modern clinical or forensic collections which are often biased with regard to geographical, cultural and/or socioeconomic background (Cox, 2000). Moreover, some of these reference collections such as the Hamann-Todd collection (Cleveland, Ohio, USA) which was used to devise widely applied ageing methods on the pubic symphysis (Todd, 1920) and auricular surface (Lovejoy *et al.*, 1985), lack sufficient documented proof of age and sex at all (Cox, 2000). In addition, modern populations are very likely to have an entirely different background in terms of diet and living environment, therefore adding further constraints as to their comparability to archaeological samples. Therefore, even by attempting to choose methods developed on populations of similar geographic origin or socio-economic background, the possibility of major differences in ageing rates cannot be excluded. Consequently, all currently available ageing techniques may not be appropriate for the population under study and therefore the true chronological age of the individuals might not be reflected (Cox, 2000). Consequently, they may not be representative for the population under study. However, considering multiple lines of evidence to determine age-at-death as shown in Table 7.8 is crucial to balance the effects of variation in individual traits recorded (Saunders *et al.*, 1992, Kemkes-Krottenthaler, 2002). Some researchers have advocated the application of Bayesian statistical analysis as a means of overcoming the bias created by reference-series (Konigsberg & Frankenberg, 1992, Millard & Gowland, 2002, Chamberlain, 2006: 113–119). This method was not applied in this study.

7.2.7.ii. Estimating sub-adult age-at-death

7.2.7.ii (a) Introduction

Estimating age in sub-adult remains considers different aspects of skeletal and dental maturation. These follow known chronological schemes and allow for a relatively accurate estimation of age at death in comparison to adult ageing methods. The main shortcoming of all age estimation methods applied to sub-adult human remains is the fact that they derive from observations made on the developing teeth and bones of modern children. However, the timing and sequence of development, in particular with regards bones, is known to be highly susceptible to negative environmental influences such as disease or malnutrition, influences highly likely to have affected past human populations. In addition, growth patterns are known to vary between male and female children. Therefore, the additional persistent lack of reliable methods to sex sub-adult individuals (see Section 7.2.6) further limits the accuracy with which age-at-death can be determined (Scheuer & Black, 2000a). Another problem is the fact that a considerable number of these standards have been devised using very small (modern) sample sizes, largely limiting their reliability (2004). Consequently, even though age-at-death can be much more precisely estimated than in adults, sub-adult aging still has to be confined to relatively broad ranges. The accuracy for which an age estimate can be obtained varies according to the age range observed and the number of developmental features observed for each individual. With increasing age children become more likely to be exposed to external influences and thus the most accurate values can be obtained for young sub-adult skeletons (Saunders, 2008).

7.2.7.ii (b) Developmental stages of the teeth

Dental development is generally considered to be the most reliable age marker in sub-adult remains (O'Connell, 2004). It comprises two different processes: tooth formation and tooth eruption which both follow a very tight chronological scheme and can therefore be used in estimating age. Its major strength lies in the fact that, in contrast to bone, dental development is largely independent of external influences and resistant to hormonal and genetic disturbances. Only tooth eruption can be affected by dental disease and physiological stress and therefore it is slightly less reliable than tooth formation. Moreover, due to its vulnerability to environmental factors, dental eruption has been shown to be more variable between different populations and socioeconomic groups (Smith, 1991). Therefore, many have argued that caution is needed when applying common dental eruption standards to samples of different environmental or geographical origin (Halcrow *et al.*, 2007)

In order to infer age-at-death in the sub-adult remains at Amara West, both tooth formation and tooth eruption were considered. The stages of dental formation were recorded following the standards proposed by Moorees and co-workers (Moorees *et al.*, 1963a, b, Smith, 1991). This system is widely applied in bioarchaeological studies and generally considered the most reliable (Smith, 1991). One of the short-comings of this method is that for complete dentitions radiography is required to examine the degree of development. However, due to the state of preservation of the Amara West sample, this has only very rarely been a necessity. In addition, the system proposed by Ubelaker (1989) which considers both tooth formation and tooth eruption was applied, even though it is acknowledged that this method was devised on pre-Columbian Native American remains and are therefore only broadly comparable to the collection under study.

7.2.7.ii (c) Skeletal development

Estimating age from bone development can be achieved based on two aspects: appearance and fusion of epiphyses and bone length (Brickley, 2004c). However, there are again numerous problems inherent to the process itself, but also with regard to the analytic methods available. In contrast to teeth, maturation of bones is significantly more variable and vulnerable to internal and external influences such as genetic factors, disease or malnutrition, considerably limiting their value in bioarchaeological research (Scheuer & Black, 2000a, Saunders, 2008). Timing of epiphyseal fusion is particularly problematic as it varies considerably between the sexes, a variable that is almost always unknown in archaeological samples (see below) and a considerable time span can elapse between the onset and completion of epiphyseal fusion (Scheuer & Black, 2000a).

A number of standards are available both for recording long bone diaphyseal length and epiphyseal union. With regard to the standards used for assigning age at death, again most of them have been developed on modern and often very small non-adult samples which most certainly have a different environmental, nutritional and socio-economic background to those of archaeological samples and are therefore not necessarily comparable (Brickley, 2004c). Equally problematic is the fact that many of the standards were developed using radiographs rather than dry bones (Brickley, 2004c). It has been shown that identification of epiphysial fusion stages from radiographs can be very difficult and prone to inter-observer error, and in addition, there seem to be differences between ages associated with radiographic stages and stages observed in dry bone (Scheuer & Black, 2000b: 12). Moreover it has to be taken into account that, due to large genetic influences, growth patterns vary between populations (Saunders, 2008). Therefore, standards developed for one population do not necessary to give an accurate reflection of chronological age in another and it is advisable to choose standards developed on skeletal samples of comparable origin and geographic location (Saunders, 2008). Another issue often arising in bioarchaeological studies is preservation. Small epiphyses, especially in very young children, are often not excavated or do not survive due to taphonomic reasons. Therefore, appearance of epiphyses has not been proven to be a very useful aging technique in bioarchaeology (Saunders, 2008).

Bearing the above mentioned methodological shortcomings in mind, developmental stages of the skeleton were recorded at Amara West, using stages of epiphyseal union as well as long bone length. Long bone length was measured using sliding callipers and an osteometric board according to the suggestions by Buikstra & Ubelaker (1994) and lengths were recorded to the nearest millimetre. As for epiphyseal union, all available epiphyses were recorded and classified into the developmental stages: non-union, partial union and complete union (Buikstra & Ubelaker, 1994: 41).

Age estimates based on epiphyseal union were obtained using the data given in Scheuer & Black (2000b) as recommended by Brickley (2004c) despite acknowledging the fact that some of these data were collected from very small samples and are therefore not necessarily robust. With regard to long bone length, the most widely applied standards are again those cited in Scheuer & Black (2000b) which are mainly based on modern European or American clinical samples. Given the different geographical and environmental background of the Amara West sample, measurements given in the detailed growth study of human remains from the Lower Nubian sites of Kulubnarti and Wadi Halfa reported by Hummert & Van Gerven (1983) were also taken into consideration. Even though they are derived from an archaeological sample of unknown age, standards were developed in relationship to dental development. In foetal skeletons age estimation was determined based on the standards developed by Fazekas & Kósa (1978, Kósa, 1989) which were devised from a large forensic sample from Hungary. They are widely accepted in bioarchaeological studies (Buikstra & Ubelaker, 1994), even though concerns have been raised as to their validity as the sample on which they developed their method included a large number of individuals of unknown age-at-death (Scheuer & Black, 2000a)

7.2.7.iii. Estimating adult age-at-death

7.2.7.iii (a) Final stages of skeletal maturation

Young adult individuals can be more easily aged than older adults, based on a number of epiphyses including the iliac crest, medial end of the clavicle, sacral bodies as well as the jugular growth plate in the skull which seem to persist into the late 20s and early 30s (Cox, 2000). However, a number of studies have shown that the exact timing of final skeletal maturation can again vary significantly between the sexes, populations and in relationship to environmental and socioeconomic factors (Cox, 2000).

Each of these epiphyses was examined and, if scored as not completely fused, individuals were classified as young adult. Nevertheless, due to known chronological variability and the fact that the sample analysed in this study differs significantly in geographical, temporal and socioeconomic background to any of the samples on which common standards were developed, more precise age estimation was not attempted.

7.2.7.iii (b) Wear stages of the molar teeth

The degree of dental wear provides another useful tool to estimate age-at-death in skeletal remains (Buikstra & Ubelaker, 1994: 21, 47, O'Connell, 2004). It is based on the fact that tooth enamel starts to wear away as soon as the teeth are full erupted and in occlusion (Chamberlain, 2006: 106). Methods commonly employed in bioarchaeological studies were developed by Miles (1963, 2001) as well as Brothwell (1981: 72). However, again, both methods pose several methodological problems. Both were developed on archaeological samples of unknown age and therefore already come with an associated methodological error (Chamberlain, 2006: 106). In addition, more than any other characteristic used in aging, the rate of wear is highly dependent upon a wide range of biological, cultural and environmental factors such as food sources, food preparation techniques and predisposing occupational as well as pathological features, developmental disorders and other genetic influences (Walker *et al.*, 1991, Chamberlain, 2006: 106–107). In order to detect these possible sources of error it is therefore very important to take into account the archaeological and environmental background of the population under study. Moreover, it has been suggested that it is possible to calibrate dental wear in juvenile skeletons at a site, where the degree of wear can be matched amongst individuals with relatively well-defined age ranges, in order to gain a general idea of the degree of wear affecting a population (Miles, 1963, Walker *et al.*, 1991).

However, the problem of environmental influences (e.g. the high amount of sand in the environment, and the use of granite grinding stones) is highly relevant for the inhabitants of Amara West. Consequently, the degree of dental attrition is exceedingly high, which is also manifest in a high rate of dental pathologies and ante-mortem tooth loss. Being aware of all these shortcomings, Brothwell's (1981: 72) method was used in this study, mainly due to lack of an adequate sub-adult sample at Amara West that be could be used to calibrate wear rates. The results were taken into account in combination with all other indicators of age at death present in each individual but not used as a sole ageing criterion.

7.2.7.iii (c) Degeneration of the pubic symphysis

The pubic symphysis, forming the anterior articulation of the two pelvic halves was one of the earliest features to be recognised as showing age related changes in the adult skeleton (Todd, 1920). Since then, the method has been revised several times (e.g. McKern & Stewart, 1957, Nemeskéri *et al.*, 1960, Gilbert & McKern, 1973). The most widely applied approach at present, also employed in this study, follows the suggestions by Brooks & Suchey (1990) and uses a six-stage system of degenerative changes based on the system derived by Todd (1920) with different sequences for male and female. The method was developed on a large sample from modern forensic cases of known age collected during the late 1970s in Los Angeles (Brooks & Suchey, 1990). Using this ageing method relies on comparing symphyseal surfaces with a set of casts representing each stage, which is complemented by detailed descriptions of the morphological characteristics. This method is currently considered to be the most reliable ageing technique available for bioarchaeological analysis (Chamberlain, 2006: 106). However, there are several limitations and concerns about the method such as the large age ranges for each category (Cox, 2000), inter- and intra-observer error (Saunders *et al.*, 1992) and population-specific variation in the degenerative process (e.g. Hens *et al.*, 2008, Kimmerle *et al.*, 2008). Tests on known-age samples have further shown that the method failed to provide adequately accurate results (Saunders *et al.*, 1992, Molleson & Cox, 1993) and tends to over-estimate individuals under 40 and under-estimate those over 70 (Cox, 2000). On a practical level, one of the main limitations concerning its applicability to bioarchaeological studies is the fact that, due to its fragility and position within the body, it is often not, or very poorly, preserved in archaeological contexts (Cox, 2000).

Despite these limitations, pubic symphysis morphology was examined and taken into account in age estimation of adults in the Amara West sample in combination with all other available indicators (O'Connell, 2004).

7.2.7.iii (d) Degeneration of the auricular surface

This ageing method considers changes on the auricular surface of the innominate bone which articulates with the sacrum at the sacroiliac joint. The method was developed by Lovejoy and co-workers (1985) and uses alterations in surface configuration to place individuals in different age categories. Unfortunately, this method again provides a number of problems. Due to the fact that categorisation is based on comparison with published black-and-white photographs and a description alone, generated data can be difficult to replicate and the method has been found to lead to a high degree of intra- and inter-observer error. In addition, research on known age archaeological samples has revealed considerably inaccuracies (Murray & Murray, 1991, Saunders *et al.*, 1992, Hens *et al.*, 2008). In addition, as already outlined above, the method was devised using the Hamann-Todd collection which is considered highly problematic due to known uncertainties in documentation of age and sex of the individuals (Cox, 2000). It also considers male and females together. Thus, it has been argued that this method needs more research to better understand the age changes occurring in this joint before it can provide more accurate data for adult age estimation (e.g. Buckberry & Chamberlain, 2002, Falys *et al.*, 2006).

Nevertheless it has been proven particularly useful in archaeological assemblages as this area of the pelvis has a much better survival rate than the pubic symphysis. As this also holds true for the Amara West sample, the method was also employed in the present study.

7.2.7.iv. Age categories

As a consequence of the above mentioned shortcomings of ageing methods at present available, age-at-death in human remains can still only be presented by placing individuals into broad age categories. For the adult range this study uses the categories suggested by Buikstra & Ubelaker (1994: 9) as they are the most widely used in bioarchaeology and allow for greater comparability between archaeological groups (see Table 7.9). Furthermore, in order to attain a more detailed insight regarding when death occurred in a child's life, which is a significant indicator of general living conditions during growth (see Section 4.3.2) more refined sub-adult age ranges based on maturational criteria were used (Scheuer & Black, 2000a).

Fetus	in utero – birth
Neonate	0–1 year
Young infant	1–5 years
Old infant	6–12
Adolescence	13–20
Young adult	21–35 years
Middle adult	36–50 years
Old adult	>50 years
Adult indetermined	

Table 7.9 Age categories used in this study

7.2.8. Metrical analysis

7.2.8.i. Introduction

Osteometry was one of the earliest research foci to develop in bioarchaeology, mainly driven by the prevailing interest in racial origins of human populations in physical anthropological study during the late 19th and early 20th century (Pietrusewsky, 2008). Since then, the array of possible applications have been widely extended and, when systematically studied at a population level, osteometric data are considered a valid tool to address research questions that concern kinship, individual sex, stature, growth patterns and living conditions (e.g. Larsen, 1997, Mays, 2000). Due to its long history, many different measurements have been defined for the skull and post-cranium. While many are unknown and have relatively little significance, others are widely recognised and of standard use in bioarchaeological studies worldwide. Generally, all textbooks since the 1960s have advocated the use of the original definitions of the landmarks and measurements taken by Martin & Saller (1957) (e.g. Brothwell, 1981, Knußmann, 1988, Buikstra & Ubelaker, 1994). Nevertheless, recommendations as to which measurements to include in basic osteological studies vary and largely depend on the level of study and the nature of the skeletal assemblage (e.g. archaeological vs. forensic). The final choice as to what measurements to be included in individual studies varies according to their relevance to the research questions and level of preservation of the skeletal assemblage under study (Brothwell & Zakrzewski, 2004).

All measurements were taken using an osteometric board or sliding callipers. The choice of what measurements to include in the analysis was based on the following considerations: (1) general preservation and (2) research questions (see Sections 1.3 and 7.2.9 for a more detailed rationale). The full list of postcranial measurements included in this study is given Table 7.10. Cranial measurements were not included in the study as the general level of preservation of the skull was poor and the sample size would have been very small for individual measurements. In addition, this study did not address any research questions that necessitated craniometric data.

Element	**Measurement**	**Code**[4]
Humerus	Maximum length	H1
	Maximum diameter head	H9
	Maximum shaft circumference	H7a
	Maximum midshaft diameter	H5
	Minimum midshaft diameter	H6
Ulna	Maximum length	U1
Radius	Maximum length	R1
Clavicle	Maximum length	C1
Femur	Maximum length	F1
	Oblique length	F2
	Antero-posterior AP) midshaft diameter	F10
	Mediolateral midshaft (ML)diameter	F9
	Maximum head diameter	F15
Tibia	Maximum length	T1
	Bicondylar width	
	A-P diameter at nutrient foramen	T8a
	M-L diameter at nutritient foramen	T9a
Fibula	Maximum length	

Table 7.10 Measurements taken in this study

7.2.9. Stature

Even though growth potential is determined by genetic factors, external influences such as disease or nutritional status influence can affect achieved stature. Therefore, long bone length is generally considered a very good indicator of living conditions for the growth period in past human populations (Goodman & Martin, 2002). However, as with a large number of analytical methods commonly applied to the study of archaeological human remains, calculating stature from dry bone is not without serious shortcomings. Stature estimation is based on the assumption that overall stature directly correlates with the length of individual long bones. Over the past decades a large number of different formulae have been developed, allowing for calculation of body height (e.g. Trotter & Gleser, 1952, 1958, Sjovold, 1990). However, tests on these formulae on known height skeletons have shown that the accuracy of all these formulae is fairly low. Again, a main obstacle lies in the strong genetic component that affects body size, and that there are major differences between the sexes and between groups when correlating body size and

[4] Martin & Saller 1957

limb length. Consequently, formulae developed for one specific group cannot readily be applied to individuals with a different ancestral background (White *et al.*, 2011: 420). Additional limitations reflect the fact that most formulae available to the bioarchaeologist were developed from relatively modern populations with, almost certainly, different nutritional and physiological statuses. They may therefore provide seriously flawed results when applied to archaeological assemblages.

In order to estimate stature of the individuals, this study used the regression formulae developed by Raxter *et al.* (2008), based specifically on ancient Egyptian populations. The calculation is as described in Table 7.11

Element	**Formula**	**StD**
Males		
Femur	2.257*F1+ 63.93	3.218
	2.253*F2 + 64.76	3.226
Tibia	2.554*T1 + 69,21	3.002
Humerus	2,594*H1 + 83.85	4.218
Radius	2.641*R1 + 100.91	3.731
Females		
Femur	2.340*F1 + 56.99	2.517
	2.341*F2 + 57.63	2.511
Tibia	2.699*T1 + 61.08	1.921
Humerus	2.827*H1 + 70.94	2.732
Radius	2.509*R1 + 96.73	4.057

Table 7.11 Stature estimation formulae devised by Raxter *et. al.* 2008 (in cm, abbreviations refer to codes outlined in Table 7.10)

The formulae were derived using an anatomical model to estimate overall body height. The maximum long bone measurements and measuring techniques included in the study are outlined in Section 7.2.8/ Table 7.10.

Nevertheless, the results can only be seen as rough estimates of true stature. Therefore, analysis of bone growth was also carried out considering "non-manipulated" long bone length as has recently been suggested by Brothwell & Zakrzewski (2004) and Steckel (1995). Analysis only included adult individuals where the fusion of all epiphyses and full eruption of the third molar indicated that skeletal maturation was complete.

7.2.10. Palaeopathology

7.2.10.i. Introduction

Recording pathological changes in human skeletal remains is even less straightforward than recording demographic parameters and, despite repeated calls for the need for standardisation of recording there is still no consensus about recording protocols in palaeopathological research (e.g. Buikstra & Ubelaker, 1994: 107, Larsen, 1997: 340, Roberts & Connell, 2004). However, adhering to such protocols would allow for broader inter-population comparison (Larsen, 1997: 340, Roberts & Connell, 2004). This step is crucial in addressing one of the major research objectives in palaeopathology today, to gain a better understanding of evolutionary patterns of diseases and their impact on biocultural adaptations in past human populations (Roberts & Connell, 2004, Ortner, 2011).

Attempts to define such protocols in order to enable comparability between studies and to allow for independent replication of data have been made by a number of researchers over the past years (e.g. Schultz (1988); Steckel & Rose (2002) and Steckel *et al.* (2006) for the Global History of Health Project (GHHP)) which are based on the standards produced by Buikstra & Ubelaker (1994) and Roberts & Connell (2004).

The current research presents a combination of methodological approaches, which have been adjusted and refined in order to address the outlined research objectives, namely to study the health status of the inhabitants of Amara West based on the occurrence of selected "stress" markers. Rather than focussing on the diagnosis of a specific disease, these skeletal and dental markers are generally considered to provide a valuable insight into general disease load and nutritional status in a population (Lewis & Roberts, 1997, Goodman & Martin, 2002). These markers represent a framework which may allow for cross-cultural comparisons in order to allow for an analysis of human adaptation on a global scale. They are now widely accepted and applied in bioarchaeological studies that address the impact of living conditions on health in past human populations for many geographic areas and historic periods including broadly contemporary sites in Egypt and Nubia (e.g. Goodman *et al.*, 1984, Steckel & Rose, 2002, Buzon, 2006b, Cohen & Crane-Kramer, 2007, Buzon & Judd, 2008). They were therefore considered appropriate for addressing the research questions posed in this present study.

The list of indicators of physiological stress chosen for this study is based on the protocol outlined by Goodman and Martin for the GHHP (2002), a protocol which is now commonly applied in bioarchaeological studies and therefore also allows for good comparison of the Amara West population with other groups both within Nubia (e.g. Buzon, 2006b, Buzon & Judd, 2008) as well as outside (e.g. Steckel & Rose, 2002, Redfern, 2008). However, some adjustments had to be made with regard to recording methods (specified in Section 7.2.10) as some methods observed in the GHHP[5] present challenges and appear to oversimplify more complex phenomena such as changes in the orbital roof (e.g. Wapler *et al.*, 2004). Thus, while adhering to the original catalogue of markers suggested by Goodman and Martin (Goodman & Martin, 2002), some adaptations had to be made in accordance with current palaeopathological literature. These are outlined in the text below. In addition, the range of health indicators was extended with other dental pathologies and a more specific consideration of non-specific infections.

The main objective of any such recording protocol is the detailed and objective description of pathological changes which are the necessary basis for any further differential diagnosis. Any lesions need to be recorded in a way that allows other researchers to review and evaluate diagnoses and to reach independent conclusions (e.g. Buikstra & Ubelaker, 1994: 108, Lovell, 2000, Roberts & Connell, 2004). This can only be achieved if researchers adhere to a clear, unambiguous terminology when recording pathological changes (e.g. Ortner, 1991, Buikstra & Ubelaker, 1994: 107, Lovell, 2000). In compliance with these requirements, any pathological lesions observed in the Amara West remains was recorded following the descriptive protocol outlined by Roberts & Connell (2004) comprising

(1) bone element and side affected

(2) location on the element

(3) extent of the lesion

(4) type of lesion (bone formation/destruction)

(5) in cases with bone formation, the type of newly formed bone

(6) evidence and degree of healing

However, while these parameters were generally documented for any pathological change observed in the sample, differential diagnosis of specific disease processes was not the aim of this study. Rather, the aim was to conduct a general analysis of indicators of ill health and malnutrition in order to gain an insight into living conditions of the population living at Amara West. Therefore more refined recording methods allowing for the

[5] http://global.sbs.ohio-state.edu

systematic analysis of skeletal and dental indicators of physiological stress had to be employed which are described in more detail in the following sections of this chapter.

Following recommendations by Roberts & Connell (2004) prevalence rates for indicators of physiological stress and disease used in this study were calculated as true prevalence rates (TPR), e.g. the ratio of the number of bones, teeth or sections of a bone present to the number of respective elements affected by the condition under study. Prevalence rates were further calculated for individuals. The threshold for inclusion of an individual in the calculation of individual rates varied between different types of indicators and will be specified separately in the methods used for recording of each indicator.

7.2.10.ii. Recording and diagnostic methods

The range of diagnostic tools and methods for studying disease in past human populations that are currently available to the palaeopathologist has expanded significantly over the past decades. Recent technical advances comprise the analysis of ancient pathogen DNA, palaeohistopathology, computed tomography (CT), and scanning electron microscopy (SEM), which all complement traditional macroscopic methods of diagnosing diseases and allows for more refined differential diagnoses of pathological changes encountered in human remains (e.g. Ortner, 2003: 9–10, Pinhasi & Mays, 2008, Roberts, 2009: 191–193, Ortner, 2011). However, as the detection of specific disease processes was not a major focus of this study, the examination of pathological lesions was first and foremost based on macroscopic observation, with descriptions, aided by the use of a hand lens. Addressing the outlined research objectives, i.e. the observation of selected indicators of stress in order to assess disease frequency in the population under study, did not require advanced diagnostic tools.

Plain-film radiographs were only taken occasionally to clarify diagnoses, mainly when dealing with possible fractures. Radiography of the tarsal bones of Sk201-4 and skeletal elements of Sk244-8 were carried out in the Department of Conservation and Scientific Research at the British Museum using a Seifert Isovolt DS1 X-ray tube. The calcified structures associated with Sk244-4, Sk244-6, Sk243-3, Sk237 and Sk305-2 were radiographed at the Department of Archaeology, Durham University (Portable GE Medical MPX X-ray unit) and processed digitally using a Kodak Point-of-Care CR120 system. Diagnosis of the pathological changes observed in Sk244-8 as well as the calcified structures associated with Sk237 was further supported by Scanning Electron Microscopy carried out in the Department of Conservation and Scientific Research at the British

Museum (Hitachi S-3700N variable pressure scanning electron microscope). An integrated Energy-Dispersive X-Ray Spectroscopy (EDS) was used to characterise the chemical composition of the structure. 3D images of SS68 and SS69b were produced using a 3D surface scanner (NextEngine 3D Laser Scanner).

In addition to descriptive and frequency recording, pathological changes were documented photographically and locations of major pathological changes were also recorded on separate visual recording forms.

7.2.10.iii. Dental disease

7.2.10.iii (a) Dental disease – General remarks

Dental pathologies are by far the most commonly encountered form of disease in archaeological human remains (Hillson, 2008). Dental disease is also the category of disease where there seems to be the least consensus regarding recording standards and there are still considerable methodological differences between UK, US and continental Europe (Hillson, 2001). The choice of methods was based on considering what needed to be addressed according to the outlined research questions. All adult and sub-adult individuals with preserved erupted teeth were examined for evidence of dental disease. All teeth were examined macroscopically only, in good light and using a hand lens if evidence was unclear. Individuals were included in the calculation of individual prevalence rates if either the condition was present or if they had at least three teeth (attrition, caries, calculus, DEH) or tooth sockets (AMTL, periodontal disease, periapical lesion) preserved. This convention was introduced in order to decrease the risk of overestimating the prevalence.

7.2.10.iii (b) Dental wear and attrition

The degree of dental wear is a major influential factor in the frequency of dental disease (Hillson, 2008) and therefore it was examined alongside evidence for dental disease and taken into account in this study. Dental wear was examined macroscopically on all identifiable teeth present in each individual, both adults and sub-adults. Following the recommendations of Buikstra & Ubelaker (1994: 52–53) scoring of dental attrition in the incisors, canines and premolars was carried using the system scheme proposed by Smith (1984), and wear of the molars was additionally scored following Scott (1979).

7.2.10.iii (c) Dental Caries

While diagnosis of advanced dental caries is a relatively easy task, recognising the initial stages of caries still represents a major problem. A carious lesion begins as a small white opaque or brown stained area on any dental surface area (Hillson, 2001). Recognising these in archaeological teeth is difficult and may not be achieved without histological examination. Moreover, lesions may be mimicked by taphonomic changes (Hillson, 2008). As histological examination was not an option, early carious lesions were not included in the analysis. In accordance with the guidelines proposed by Roberts & Connell (2004), carious lesions were graded following the suggestions of Lukacs (1989): (1) pit or small fissure caries, (2) medium to large but with less than one half of the tooth crown destroyed, (3) large – more than one-half of the tooth crown, (4) complete destruction of the tooth crown. The use of a dental probe in order to diagnose grade 1 caries, as recommended by Lukacs (1989), was omitted, as this process is likely to scratch the tooth surface. The location of each lesion was recorded according to which surface of the crown was affected.

All individuals, including sub-adults, with erupted teeth present were examined for caries and included in the calculation of caries prevalence. Due to the poor state of preservation of the teeth in general it is however recognised that the obtained prevalence rate largely underestimates the true prevalence within the population. In addition, caries frequencies were expressed as the percentage of the total number of teeth present. Applying a tooth correction factor to account for the number of missing teeth and enhance comparability with modern data was not considered. This was because there are too many possible reasons for missing teeth, other than caries, including cultural practices and a high degree of dental wear. This latter reason could have lead to antemortem tooth loss (AMTL) in the Amara West sample and the fact that the frequency of caries is very likely to be obscured by the high degree of post-mortem tooth loss (PMTL).

7.2.10.iii (d) Ante-mortem tooth loss (AMTL)

All available alveolar bones were examined and recorded for evidence of AMTL. If a tooth socket showed any evidence of resorption, AMTL was recorded as present. If no bone formation was present, a tooth was considered lost post-mortem even though it is recognized that cases of very early tooth lost may go undetected (Lukacs, 1989).

7.2.10.iii (e) Periapical lesions

Periapical lesions were recorded as to their presence and location of their drainage sinus (buccal/labial, lingual, internal, maxillary sinus, nasal cavity) (Lukacs, 1989, Roberts & Connell, 2004). Additional characteristics referring to the sinus size, state of activity (healed or unhealed) and exposure of tooth root were also noted, where appropriate (Roberts & Connell, 2004). Quantification of the size of the periapical lesion, as for example suggested by Lukacs (1989), was not undertaken. Examination was carried out on all individuals with erupted teeth. However, not all periapical lesions necessarily develop drainage sinuses, or external drainage may not be present in the earlier stages of the disease process. In order to detect a true prevalence rate for periapical lesions, radiographs of all jaws would be required which was not carried out in this present study. Therefore, it has to be recognised that the true prevalence rate for periapical lesions may be higher. Frequencies were calculated based on the number of all alveolae sufficiently well preserved for examination.

7.2.10.iii (f) Dental Calculus

All individuals with erupted teeth were examined for dental calculus. Dental calculus was recorded for each tooth individually using the three grade system of Brothwell (1981) which categorises the occurrence of calculus as mild, moderate or severe. However, as this system is highly subjective (Roberts & Connell, 2004), a more quantifiable approach as suggested by Greene *et al.* (2005) was applied. This system considers calculus covering less than 1/3 of the tooth surface as mild, between 1/3 and 2/3 of the surface as moderate and more than 2/3 of tooth surface as severe. In addition, calculus was noted to be either supra- or subgingival. Based on the observation that dental calculus if present was often very brittle and could easily flake off postmortem, calculus frequencies were only calculated per individual rather than per tooth as this would have led to a significant underestimation of frequency. However, the true prevalence rate is still very likely to be higher.

7.2.10.iii (g) Periodontal disease

Following the standards of Buikstra & Ubelaker (1994) periodontal disease is commonly graded according to the three stage system suggested by Brothwell (1981) which categorises the degree of gradual loss of the alveolar bone as either mild, moderate or severe. However, as this system is subjective grading was carried out following the suggestions of Roberts & Connell (2004) where bone loss of 2–3mm below the cemento-enamel junction is considered mild, 3–5 as moderate and severe periodontal disease was recorded if most of the tooth root was exposed. Periodontal disease was examined in all areas of intact alveolar bone. However, systematically recording periodontal disease poses several difficulties. On one hand it is difficult to distinguish between periodontal disease and remodelling of alveolar bone caused by eruption or teeth wear which is a normal physiological process and must not be considered pathological (Hillson, 2008). Furthermore, the thin alveolar bone is highly vulnerable to post-mortem changes which can mimic periodontal diseases as well. Thus, alveolar bone was examined and recorded through use of a hand lens only in order to avoid confusion with post-mortem damage. As periodontal disease is a generalised process, the results were only analysed according to number of individuals affected.

7.2.10.iii (h) Dental Enamel Hypoplasia

Dental enamel hypoplasias represent phases of growth arrest in the formation of dental enamel and are expressed as transverse lines, grooves or pits in the tooth crowns (Lukacs, 1989). Causes include systemic physiological stress, localized trauma and, less commonly, genetic disturbances (Goodman & Rose, 1991). Defects were classified according to the scheme of Lukacs (1989) as the presence of a pit, groove or line. Since any systemic disruption potentially leads to hypoplastic defects on multiple teeth, individuals with only one tooth observable or displaying single lines were excluded from the analysis in order to avoid confusion with traumatically induced hypoplasias.

7.2.10.iii (i) Orbital lesions

Orbital lesions (cribra orbitalia) are diagnosed based on the presence of surface changes and pitting on the orbital roof. A grading system for recording these changes was devised by Stuart-Macadam (1991) and is now widely applied in bioarchaeological studies. However, diagnosing pathological changes in the orbital roof is not straightforward as a number of different disease processes such as scurvy or infections of the eye have been shown to produce lesions (see 4.3.4) that can be very difficult to determine based on macroscopic analysis alone (Wapler *et al.*, 2004). Therefore, it has been argued that without radiographic or histological analysis, differential diagnosis is not possible (Schultz, 2001, Ortner, 2003). Differential diagnosis of changes in the orbital roof proved to be particularly problematic in the Amara West sample as many different expressions of lesions could be observed, and a wide range of equally plausible differential diagnostic options can be considered, as has been shown by Wapler and co-workers (2004) in their analysis of nearby Missiminia.

The pathological changes affecting the orbital roof were categorised based on the system developed by Stuart-Macadam (1991) outlined below (see Table 7.12). However, a large number of individuals also displayed lesions that did not fall within this classification system and affected other areas of the orbital cavity. These changes, mainly comprising evidence of new bone formation could be indicative of scurvy but also of an infectious process affecting the eye (Wapler *et al.*, 2004), and were described using the criteria outlined in Table 7.12. In order not to confuse pathological lesions with growth related changes, only individuals over 0.5 years of age were included in the study.

0	no pitting
1	vessel impressions
2	small scattered foramina
3	small to larger pits with small coalescence
4	coalescent pits
5	trabecular outgrowth

Table 7.12 Grading system for cribra orbitalia after Stuart-Macadam (1991)

7.2.10.iv. Non-specific markers of disease

7.2.10.iv (a) <u>New bone formation</u>

New bone formation in adults results from an inflammatory process of the periosteal tissue surrounding all bones apart from joints (Ortner, 2003: 206). These changes can be indicative of a number of different pathological processes such as various specific and non-specific infectious diseases as well as trauma (Ortner, 2003: 206, Weston, 2008). Differentiating between potential causes cannot be easily achieved, and even the application of biomolecular or histological techniques does not necessarily lead to an unambiguous diagnosis. However, location, laterality and distribution of periosteal new bone deposits are important recording criteria and potentially provide differential diagnostic markers (Ortner, 2003: 206). Therefore, new bone formation was recorded regarding the parameters listed in Table 7.13. Examination was carried out macroscopically, aided by a hand lens if necessary.

Element	Location	Side	Type of bone	Distribution	Activity
		Right	woven	discrete	active
		Left	lamellar	multifocal	healing
		Bilateral	mixed	diffuse	healed

Table 7.13 Parameters recorded for bone formation

7.2.10.iv (b) Bone destruction

Evidence of bone destruction was recorded seperately according to the scheme outlined in Table 7.14. A wide range of different pathological conditions has to be considered as differential diagnoses, including neoplasms as well as a large number of infectious diseases such as treponemal diseases, tuberculosis or leishmaniasis (Ortner, 2003).

Element	**Location**	**Side**	**Distribution**	**Activity**
		Right	discrete	active
		Left	multifocal	healing
		Bilateral	diffuse	healed

Table 7.14 Parameter recorded for bone destruction

7.2.10.v. Non-specific infections

7.2.10.v (a) Non-specific infection

The presence of non-specific infectious disease was analysed based on the occurrence of new bone deposition. In order to avoid including cases of periosteal reaction due to trauma, only skeletons fulfilling one or more of the following criteria were included in the study: Regarding long bones, infectious disease was only recorded as the cause of lesions when they were observed bilaterally. Combined under the term of “non-specific infection” all types of infectious bone change, including periostitis, osteomyelitis and osteitis, were recorded macroscopically.

The diagnosis of non-specific infection in sub-adult individuals based on periosteal changes alone is still considered problematic as it is difficult to differentiate between new bone deposition occurring due to normal growth processes and pathological reactions (Lewis, 2007: 135–137). Nevertheless, non-specific infection has been convincingly identified in severe cases due to the thickness of the deposit. Bearing these pitfalls in mind, bones of infants were also examined, but only tentatively recorded as pathological if cases were severe enough to suggest an infectious rather than a developmental origin.

7.2.10.v (b) Maxillary sinusitis

The maxillary sinuses were examined seperately for evidence of possible infection, manifested in the form of pitting or new bone deposition (Boocock *et al.*, 1995a: see Plate 21.3). Included in the study were adult individuals and sub-adult individuals older than 3 years. In children below the age of 3 it has been shown that the sinuses are too porous and undeveloped to allow for any detection of pathological changes (Lewis *et al.*, 1995). In addition, caution was given to diagnosing an infection in sub-adults due to the fact that pitting in sub-adult maxillae may also be developmentally induced (Lewis *et al.*, 1995). If the maxillary sinuses were intact, an endoscope was used for examination. If changes were present, the type of new bone formation (lamellar vs. woven), location and extent were recorded. In addition, the presence of dental pathologies in the upper jaw was noted seperately as they can also lead to an infection of the maxillary sinuses (Boocock *et al.*, 1995a).

7.2.10.v (c) Infection of the ribs

Particular attention was also given to the visceral surfaces of the ribs as these areas that can display periosteal new bone formation which may be associated with an infection of the lower respiratory tract (e.g. Roberts *et al.*, 1994, Santos & Roberts, 2006). Examination was carried out macroscopically and any changes were recorded according to the system outlined in Section 7.2.10.iv.

7.2.10.vi. Pathological changes on the endocranium

Pathological changes on the inner table of the skull can be caused by a number of different disease processes such as scurvy, tuberculosis, meningitis and trauma and can, in the absence of further differential diagnostic features or analytical tools, usually not be attributed to a specific disease process (Schultz, 2001). They are particularly commonly observed in sub-adult remains and usually derive from an inflammatory process of the meninges which is manifested by new bone formation and increased impressions of the meningeal vessels (Lewis, 2007: 141), but it should be remarked that new bone formation on the endocranium can be the result of normal growth. Consequently, sub-adult individuals were examined but only diagnosed as pathological if other changes suggestive of a disease were present too.

All available skulls were examined for evidence of endocranial lesions. If present, recording included the exact location, extent and type of bone changes present.

7.2.10.vii. Trauma

7.2.10.vii (a) Fractures

Evidence of trauma was examined and recorded on all skeletal elements recovered at Amara West. A fracture was deemed present if a callus was present (indicating healing) and/ or if the bone showed abnormal angulation on healing. Only in doubtful cases was radiography employed to confirm or refute diagnosis. The parameters recorded for each fracture comprised (1) bone element, (2) side (3) location on bone, (4) type of fracture (based on the outline provided by Lovell, 1997) if not obscured by healing and (5) degree of healing. In addition, all further evidence of complications such as shortening, non-union of the fractured elements, pseudoarthrosis, infection or secondary osteoarthritis was noted. All fractures were further documented photographically.

7.2.10.viii. Diseases of the joints

7.2.10.viii (a) Osteoarthritis of the joints of the appendicular skeleton

Joints are usually complexes, formed by at least two different compartments. Within the framework of this study, compartments of each joint were examined and recorded separately (see Table 7.15). However, analysis was carried out considering the joint as a whole because this is considered of epidemiological relevance (Rogers & Waldron, 1995: 14). In order to investigate the occurrence of osteoarthritis, the following criteria were observed for absence/ presence based on the suggestions outlined by Rogers & Waldron (1995: 42–43) and the operational definitions outlined by Waldron (2009: 34): marginal osteophytes, pitting on the joint surface, alteration of the joint surface contour, new bone formation on the joint surface, or eburnation. Osteoarthritis was recorded as present if either eburnation, or at least two of the other indicators were observed. In addition, joint fusion was also recorded separately. As osteoarthritis is an age-related process that does not usually occur in children, only sub-adults from 13 years onwards were indcluded in the study.

With regard to all erosive arthropathies, due to their relatively rare occurrence their presence was only recorded in descriptive form. Differential diagnosis of specific arthropathies was based on the operational criteria outlined by Waldron (2009: 46).

Joint	Compartment	Joint	Compartment
Temporo mandibular	Mandibular condyle	Hip	Femoral head
	Temporal bonr		Acetabulum
Acromiocl avicular	Clavicle	Knee	Patellofemoral
	Scapula		Tibiofemoral surface (medial)
	Sternoclavicular surface		Tibiofemoral surface (lateral)
Shoulder	Glenoid	Ankle	Tibia: talocrural
	Humerus		Fibula: talofibular
Elbow	Humerus: capitulum		Talus
	Humerus: trochlea	Foot	Tarsus
	Ulna: trochlear notch		Tarsometatarsal
	Ulna: radial notch		Metatarso-phalangeal
	Radius: articular fovea		Proximal interphalangeal
	Radius: circumfer. art.		Distal Interphalangeal
Wrist	Radius: radioulnar surface	Sacro-iliac joint	Illium
	Radius: scaphoid surface		Sacrum
	Radius: lunate		
	Ulna: radioulnar surface		
Hand	Carpal		
	Carpometacarpal		
	Metacarpo-phalangeal joint		
	Proximal interphalangeal joint		
	Distal interphalangeal joint		

Table 7.15 Joint complexes and associated compartments analysed in this study

7.2.10.viii (b) Joint disease in the spine

In order to systematically analyse the occurrence of joint disease in the spine, different aspects were recorded separately on each vertebra (see Table 7.16). With regard to osteoarthritis, the diagnostic criteria outlined in the foregoing Section were applied and recorded separately for osteoarthritis absence or presence for each synovial joint surface given below. The vertebral bodies were examined for the presence of marginal osteophytes and evidence of intervertebral disc disease (IVD) following the diagnostic criteria suggested by Waldron (2009: 43). In addition, the vertebral endplates were examined for Schmorl's nodes which were only recorded if present. Only individuals older than 13 years were examined for evidence of joint disease in the spine.

Body	Intervertebral joints (left/right)
superior aspect	superior articular facet
inferior aspect	inferior articular facet
	transverse process (thoracic vertebrae only)
	costal facet (thoracic vertebrae only)

Table 7.16 Areas of the vertebra examined for osteoarthritis

7.2.11. Stable isotope analysis

7.2.11.i. Carbon and nitrogen isotope ratios from collagen

Samples for carbon and nitrogen isotope analysis were taken from the cortex of long bones and ribs of six New Kingdom and 14 post-New Kingdom individuals (see Table 8.72). The individuals were chosen in order to achieve a representative cross-section through both cemeteries, time periods and tomb types. Collagen extraction was carried out following the protocols established by Longin (Longin, 1971) and modified by including an additional ultrafiltration step (Richards & Hedges, 1999). Dentine was sampled in one New Kingdom and five post-New Kingdom individuals. Between 170 and 200mg of bone or dentine were removed using a saw and gently crushed with a pestle and mortar. The resulting powder was weighed into a test tube and demineralised in 0.5M HCl at 4°C for three days. The remaining solution was gelatinised at pH3 under heat (75°C) for 48 hours. The supernatant was then ultra-filtered and consecutively freeze-dried. Afterwards, the tubes were weighed again to establish the amount of remaining collagen.

7.2.11.ii. Carbon and oxygen isotope ratios from apatite carbonate

For analysis of carbon and oxygen isotope ratios from carbonate in tooth enamel, six New Kingdom and 18 post-New Kingdom individuals were chosen (see Table 8.73). The choice of individuals to be included in the study was based on considerations ensuring representative distribution across both cemeteries, time periods, and tomb types as well as general preservation of teeth. The sample was further complemented by teeth from ten animals (one sheep, two pigs, seven cattle[6]) taken from closed contexts within different areas of the settlement. Only one tooth per individual was taken for each individual. Third molars were the tooth of choice because the enamel only forms between 7 and 16 years of age (Smith, 1991) and therefore represents the best proxy for adult diet. If third molars were not available, they were substituted by second molars. The tooth surfaces were cleaned of debris using a KaVo EWL K4 dental drill. Cleaned enamel fragments were then

[6] Determination of species was kindly provided by C. Clegg, Department of Archaeology, Durham University

separated and any remnants of dentine adhering to the inner surface were removed with the drill. Sample preparation and processing was carried out by J. Peterkin in the stable isotope biochemistry laboratory of the Department of Earth Sciences at Durham University. Oxygen and carbon isotopic ratios of the carbonate content were determined following established protocols by Bentley et al. (2007). Initially, samples of enamel were coarsely ground with an agate mortar and pestle before soaking in 5% acetic acid for four hours in order to remove post-depositional carbonate contamination. The isotope ratios were measured on a Thermo Electron MAT253 mass spectrometer after extraction of CO_2 using a GasBenchII device. The obtained results are reported using the delta notation as isotope ratios are reported in the delta notation as $\delta^{18}O$ relative to the Vienna Standard Mean Ocean Water (VSMOW) and $\delta^{13}C$ values relative to the Vienna Pee Dee Belemnite (VPDB) after normalisation to values recommended by the International Atomic Energy Agency (IAEA) for the international standards IAEA-CO1 and LESVC. Accuracy was monitored using the international standard NBS-18 and in-house standard DCS01. Repeated analyses of two standards IAEA-CO1 (n=2) and DCS01 (n=8) yielded precisions of 0.05 ‰ and 0.06‰, respectively (1 s.d.) for $\delta^{18}O$, as well as 0.03‰ and 0.06‰ for $\delta^{13}C$.

7.2.12. Fourier-transform infrared spectroscopy (FTIR)

In order to exclude the possibility of calcium carbonate contamination of apatite of the analysed teeth, enamel powder remaining after stable isotope analysis of each sample was further tested using FTIR-spectroscopy using a Perkins Elmer Spectrum 2. The minerals present were identified from peaks in the spectrum using the criteria of Weiner (2010: 291).

7.2.13. Processing of data and statistical testing

Not only the way data is generated but also the means by which they are stored, accessed and analysed impact the manner and way we learn from them (Stodder, 2012). Statistical analysis of the obtained results is necessary in order to test their validity and significance (Shennan, 1997: 51, Robb, 2000). The choice of type of statistical analysis applied to the data under research is dependent on the type of data generated (Stodder, 2012). The palaeopathological data collected within this research project is mainly of categorical or nominal type. Relationships between nominal data in order to test whether diachronic differences in indicators of disease between the two samples were statistically significant were tested using a χ^2-test (Shennan, 1997: 104, Chamberlain, 2006: 43). Following recommendations by Shennan (1997: 57), values were accepted to be statistically significant if the calculated value (p) was equal or below 0.05, indicating that the observed differences is true with 95% confidence. If counts within a category were equal or below 5, a Fisher's Exact Test was employed instead. Differences between stable isotope ratios were compared using a non-parametric Mann-Whitney-U-test (Shennan, 1997: 65–68).

The data generated within this research project were stored using an MSAccess database. Data processing and calculations of prevalence rates as well as exploratory data analysis, establishing minimum, maximum or average values were carried out using MSExcel-spreadsheets. Statistical testing was conducted using SPSS software.

After outlining the methods and recording procedures applied in this study, the results obtained during analysis of the human skeletal remains and stable isotope rations will be presented in detail in the following chapter.

Chapter 8. Results

8.1. Presentation of data

This chapter presents the results of the bioarchaeological study. Results for each indicator of physiological stress and disease are compared between the New Kingdom (NK) and post-New Kingdom (post-NK or pNK) periods. Where appropriate, frequencies are further broken down into age and sex-categories. All data are presented as the prevalence of individuals or elements affected (n) according to total number of elements or number of individuals with relevant elements preserved (N). These abbreviations are used throughout the chapter unless otherwise indicated.

8.2. Demography

8.2.1. Age-at-death

		NK	Post-NK	Total
Fetus <1	**n**	0	2	2
	%	-	1.4	1.1
Neonate 0-1 yrs	**n**	0	9	9
	%	-	6.3	5.0
Infans I 1-5 yrs	**n**	0	17	17
	%	-	11.8	9.4
Infans II 6-12 yrs	**n**	1	13	14
	%	2.8	9.0	7.8
Juvenile 13-20 yrs	**n**	0	10	10
	%	-	6.9	5.6
Young adults 21-35 yrs	**n**	14	39	53
	%	38.9	27.1	29.4
Middle adults 36-50 yrs	**n**	9	25	34
	%	25.0	17.4	18.9
Old adults >50 yrs	**n**	2	9	11
	%	5.6	6.3	6.1
Adult indet	**n**	10	20	30
	%	27.8	13.9	16.7
Total	**N**	**36**	**144**	**180**

Table 8.1 Mortality distribution of the sample (n=number of burials in each age category, N=total number of individuals in each time period)

The demographic structure of the New Kingdom (1300–1070BC) and post-New Kingdom samples (1070–800BC) are presented in Table 8.1 and Figure 8.1. The New Kingdom sample consisted of 36 individuals while 144 individuals from the post-New

Kingdom period were included in the analysis. In the New Kingdom sample, the most striking demographic feature was the absence of sub-adults. Only one individual, aged 6–12 years was recovered. In contrast, during the post-New Kingdom period sub-adults comprised 35.7% (51 individuals) of the sample. Rates of sub-adult mortality were also analysed seperately and are presented below (see Table 8.4).

In the New Kingdom sample more people died in the young adult range (38.9%, 14 individuals) than in the middle (25.0%, nine individuals) and old adult ranges (two individuals, 5.6%). Similar trends were observed in the post-New Kingdom period, with young adults accounting for 27.1% (39 individuals), middle adults 17.4% (25 individuals) and old adults 6.3% (nine individuals) of the entire population. Old adult individuals were generally very rare in both samples. When comparing the two populations, the distribution of young, middle and old adults is relatively similar, with more deaths occurring in the young adult than in the older ranges. As for the adult individuals, a χ^2-test did not provide any statistically significant differences between the two time periods.

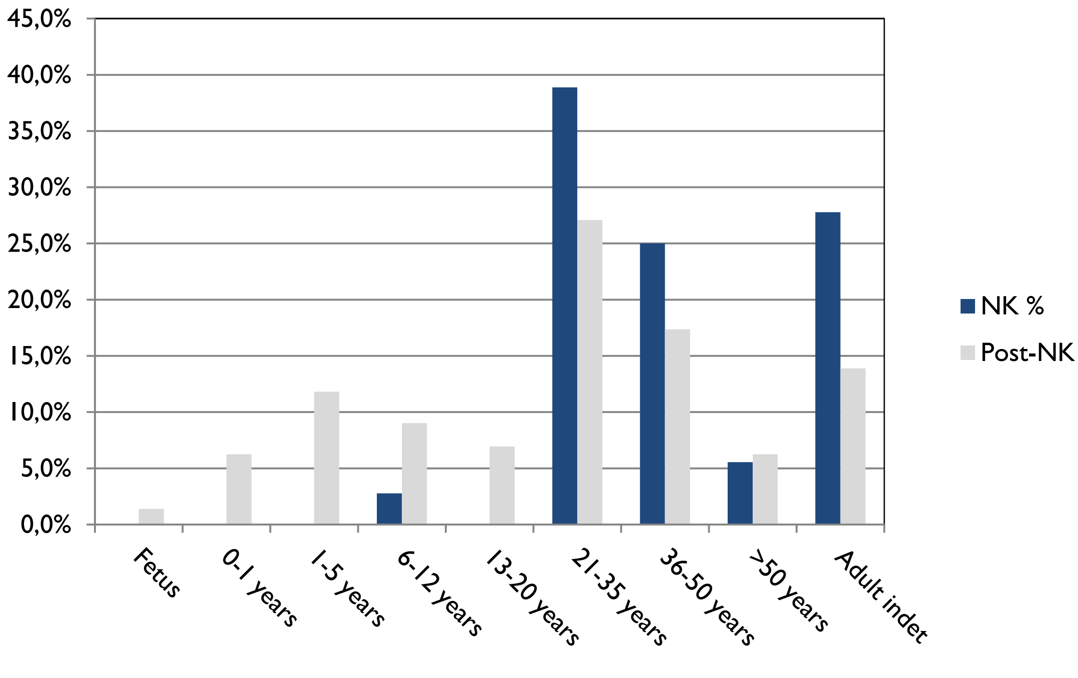

Figure 8.1 Demographic structure of the New Kingdom and post-New Kingdom samples

		NK	Post-NK	Total
Young adults	**n**	14	39	53
	%	56.0	53.4	54.1
Middle adults	**n**	9	25	34
	%	36.0	34.2	34.7
Old adults	**n**	2	9	11
	%	8.0	12.3	11.2
	N	25	73	98

Table 8.2 Mortality of adult individuals (n=number of burials in each age category, N=total number of individuals in each time period)

When comparing mortality of adults whose age could be determined (see Table 8.2), there are again no major differences between the two samples. While the percentage of young adults is similar (New Kingdom: 14 individuals, 56.0%; post-New Kingdom: 39 individuals 53.4%), the percentage of middle adults is slightly higher in the New Kingdom period with 36.0% (nine individuals) compared to 34.2% (25 individuals). As for the old adults, more people lived to this age range in the post-New Kingdom period (nine individuals versus only two in the New Kingdom) even though this could also be an artefact of the small sample size in the New Kingdom period.

		Female			Male		
		NK	**Post-NK**	**Total**	**NK**	**Post-NK**	**Total**
Young adults	**n**	6	20	26	6	17	23
	%	37.5	45.5	44.1	50.0	50.0	50.0
Middle adults	**n**	6	11	16	3	11	14
	%	37.5	25.0	27.1	25.0	32.4	30.4
Old adults	**n**	1	6	7	0	3	3
	%	6.3	13.6	11.9	-	8.8	6.5
Indet.	**n**	3	7	10	3	3	6
	%	18.8	15.9	16.9	25.0	8.8	13.0
	N	**16**	**44**	**59**	**12**	**34**	**46**

Table 8.3 Sex-related mortality rates (n=number of burials in each age category, N=total number of individuals in each time period)

Age-at-death distribution was further analysed separately for male and female individuals. The results are presented in Table 8.3 and Figure 8.2. As for the general sample, mortality was highest in the young adult age range in both the females and males (females: 44.4%, males: 50.0%). In female individuals, the number of young and middle adults was similar during the New Kingdom period with 37.5% for each group. In contrast, during the post-New Kingdom period, mortality was highest in the young adult range (45.5%). Old adult females were equally rare in both samples, with 18.8% during the New Kingdom and 15.9% during the post-New Kingdom period. Age-at-death distribution in the male sample was different. In both time periods, mortality was much higher in the young adults (New Kingdom and post-New Kingdom 50.0%) than in the middle and old adult ranges. Old adults again were generally rare, even though slightly more common in females (New Kingdom: 6.3%, one individual, post-New Kingdom 13.6%, 6 individuals) than in males (New Kingdom: 0.0%, post-New Kingdom: 8.8%, 3 individuals). The number of individuals with insufficient features preserved for aging was relatively similar with 18.8% and 13.6% in New Kingdom and post-New Kingdom females and 25.0% and 8.8% in New Kingdom and post-New Kingdom males, respectively.

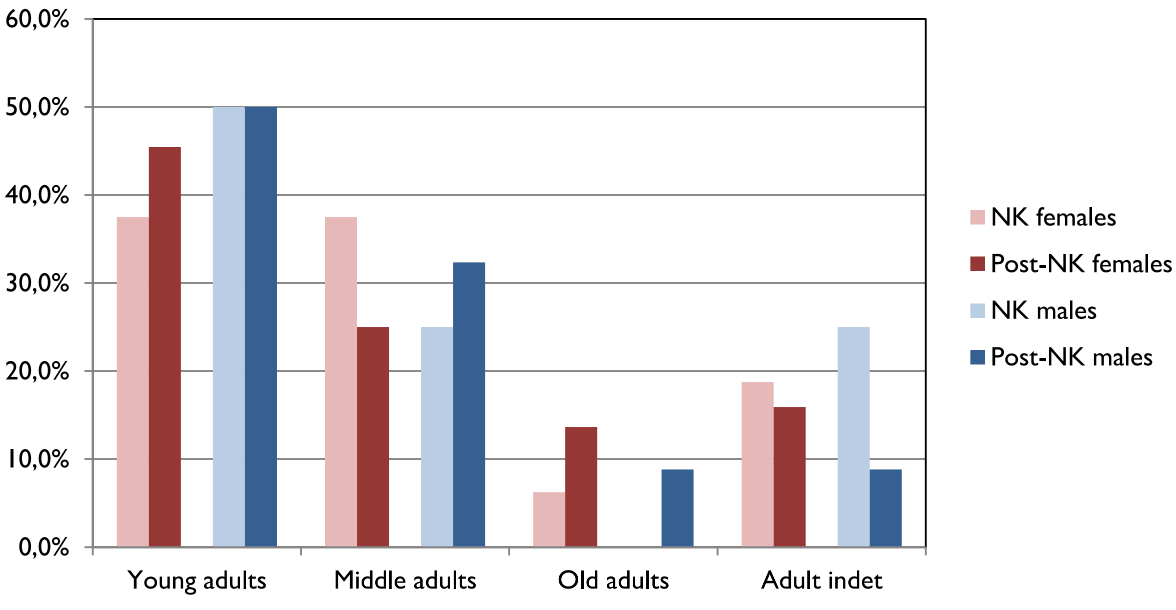

Figure 8.2 Comparison of female and male mortality

8.2.2. Sub-adult mortality

		NK	Post-NK	Total
Fetus <1	**n**	0	2	**2**
	%	0.0	3.9	**3.8**
Neonate 0–1 yrs	**n**	0	9	**9**
	%	0.0	17.6	**17.3**
Infans I 1–5 yrs	**n**	0	17	**17**
	%	0.0	33.3	**32.7**
Infans II 6–12 yrs	**n**	1	13	**14**
	%	100.0	25.5	**26.9**
Juvenile 13–20 yrs	**n**	0	10	**10**
	%	0.0	19.6	**19.2**
Total	**N**	**1**	**51**	**52**

Table 8.4 Sub-adult mortality (n=number of burials in each age category, N=total number of individuals in each time period)

Sub-adult mortality was calculated separately for the number of sub-adults present in the sample (see Table 8.4, Figure 8.3). In the New Kingdom sample, sub-adults are almost entirely absent with the exception of one individual aged 6–12 years old. During the post-New Kingdom, sub-adults were encountered more frequently, accounting for 35.5% of the entire sample. The highest number of deaths occurred in the age range between 1–5 years (33.3%). Infants below one year of age were less frequently observed, making up for 17.6% of all sub-adults. Two individuals were born prior to maturity, both of them being aged between the 7th and 8th lunar months. The number of children who died in age categories 6–12 years and 13–20 years was also relatively high at 25.5% and 19.6% respectively.

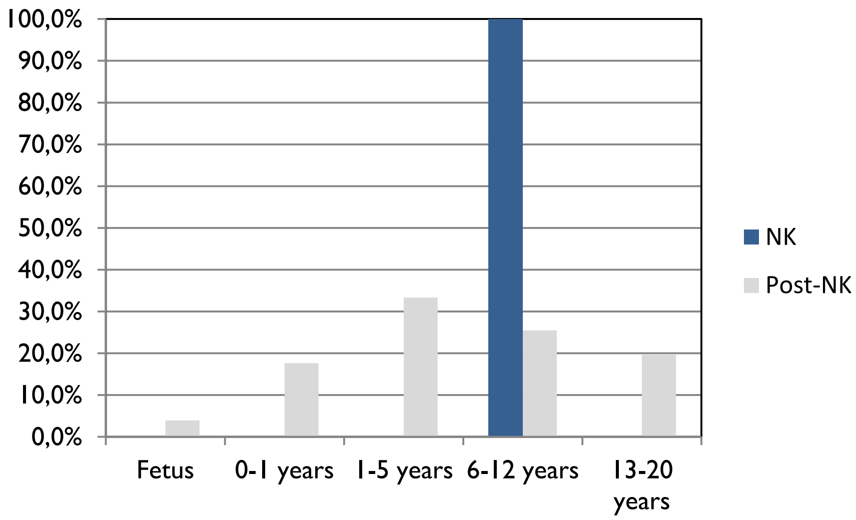

Figure 8.3 Sub-adult mortality

8.2.3. Sex distribution of the adult individuals

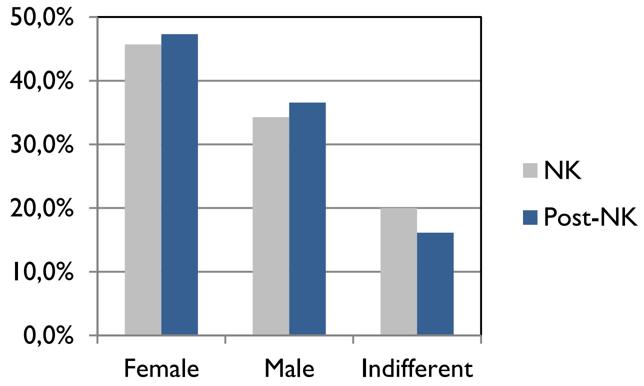

Figure 8.4 Sex distribution in New Kingdom and post-New Kingdom samples

		NK	Post-NK	Total
Female	**n**	16	43	**59**
	%	45.7	46.2	**46.1**
Male	**n**	12	34	**46**
	%	34.3	36.6	**35.9**
Indifferent	**n**	7	16	**23**
	%	20.0	17.2	**18.0**
Total	**N**	**35**	**93**	**128**

Table 8.5 Distribution of male and female individuals in the sample (n=number of burials in each age category, N=total number of individuals in each time period)

Assessment of sex was carried out on all adult individuals. The results are presented in Figure 8.4 and Table 8.5. The number of female individuals (New Kingdom 45.7%, 16 individuals, post-New Kingdom 46.2%, 43 individuals) was higher in both samples than the total number of males (New Kingdom 34.3%, 12 individuals, post-New Kingdom: 36.6% 34 individuals). The ratio of female to male individuals is very similar in both time periods. A total of 23 individuals included in the analysis of pathological changes could not be sexed due to lack of, or insufficient preservation or expression of, sexual dimorphic features. No major differences could be observed between the two chronological samples.

8.3. Stature

8.3.1. Estimated stature

The results for stature estimation are presented in Table 8.6. Stature could only be calculated for one New Kingdom female who had a value higher than the average value for post-New Kingdom females. Mean statures for the male individuals were almost similar in both time periods at 163.3cm (StD=5.90) and 163.3cm (StD=4.06), respectively, even though again sample size for the New Kingdom sample is significantly lower.

	NK			Post-NK		
	N	**Mean**	**StD**	**N**	**Mean**	**StD**
Females	1	158.6		15	155.9	3.50
Males	3	163.3	5.90	19	163.3	4.06

Table 8.6 Mean values for estimated stature of male and female individuals (length in cms, N=total number of individuals with long bones preserved)

8.3.2. Mean femur length

Mean femur length could only be analysed for the post-New Kingdom period because in New Kingdom individuals no femura were sufficiently well preserved (see Table 8.7). While the mean length for the female individuals was 41.33cm, the average length of male femora was 44.36cm.

Sex	N	Mean femur length	StD
Females	15	41.33	2.01
Males	16	44.36	2.01

Table 8.7 Mean femur lengths of male and female individuals during the post-NK period (length in cms, N=total number of individuals with a femur preserved)

8.4. Growth profiles

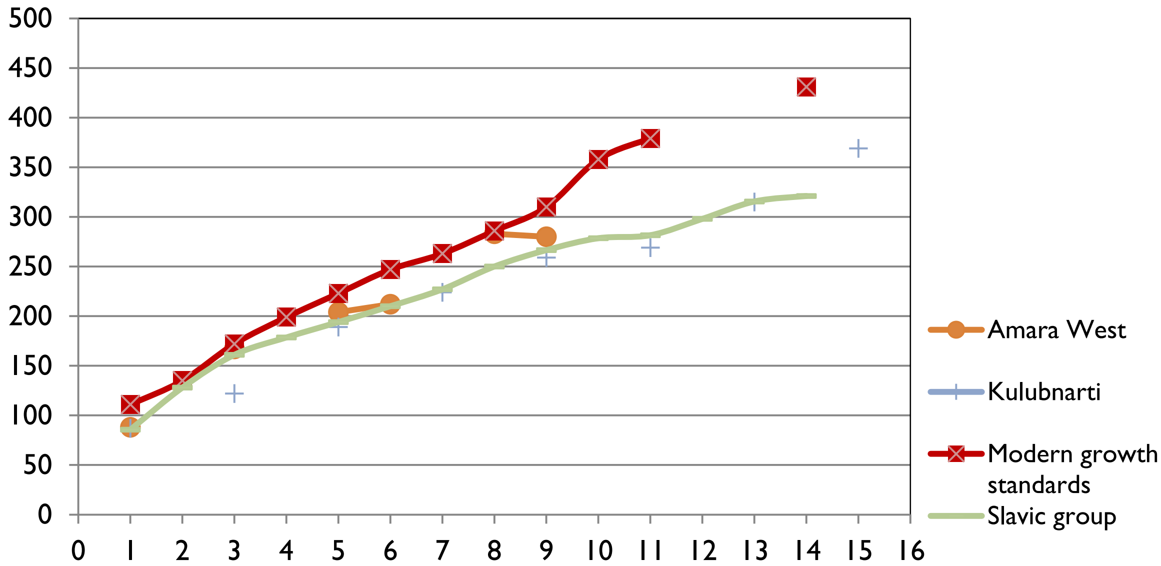

Figure 8.5 Dental age (x-axis, in years) versus mean age from long bones (y-axis, in cm)

Dental age	N	Amara West	Kulubnarti[1]	Slavic children[2]	Modern growth standards[3]
0–1 year	1	88	87	85.6	111
1–2 years	0		-	128	135
2–3 years	1	167	122	161	172
3–4 years	0	-	-	178	199
4–5 years	1	204	189	194	223
5–6 years	2	212	-	210	247
6–7 yeast	0	-	224	227	263
7–8 years	3	283	-	250	286
8–9 years	2	280	259	267	310
9–10 years	0	-	-	279	358
10–11 years	0	-	269	281	379
11–12 years	0	-	-	298	-
12–13 years	0	-	315	315	-
13–14 years	1	15	-	321	431

Table 8.8 Comparison of dental age vs age of long bone development in post-New Kingdom sub-adults and other comparative samples (N=total number of individuals with femur preserved)

In order to established growth profiles, ages obtained for dental formation (Moorees *et al.*, 1963b, a) were tabulated against ages obtained from long bone measurements (see Figure 8.5 and Table 8.8). Ages from long bones were based on two different standards ((Stloukal & Hanákova, 1978, Hummert & Van Gerven, 1983). For detailed description of rationale, methods and procedures see Chapter 7. Unfortunately the number of individuals who could be included in this analysis was low with only 15 individuals having both teeth and long bones well enough preserved to be included in the analysis. While in younger children, dental and long bone age correspond well with no differences between dental age and age estimated from long bone length, there is a marked deviation in children between 7 and 12 years. Unusually, the ages obtained from long bones consistently indicate a higher age-at-death than that seen in the teeth.

8.5. Dental disease

8.5.1. Tooth preservation

Table 8.9 presents the general preservation of the dentition and tooth sockets of both samples. Frequencies were calculated as a percentage of all possible tooth socket positions. Dental preservation was generally rather poor in both samples. Only 59.6% of the New Kingdom dentitions and 63.1% of the post-New Kingdom dentitions were observable. In both time periods, only about one quarter (New Kingdom 24.0%; post-New Kingdom 26.6%) of all permanent teeth were fully preserved either within their sockets (18.6%/ 21.5%) or as isolated teeth (5.2%/4.9%). The majority of teeth were either broken or lost prior to or after death. Values are quite similar in the New Kingdom and post-New Kingdom period, with only the percentage of teeth lost antemortem being slightly higher during the post-New Kingdom period (18.6% vs. 13.6% during the New Kingdom period).

		NK	Post-NK	Total
Dention not preserved	**n**	364	1024	**1388**
	%	40.4	39.6	**37.7**
Tooth present	**n**	167	592	**759**
	%	18.6	21.5	**20.9**
Lost pm	**n**	94	321	**415**
	%	10.5	11.7	**11.4**
Lost am	**n**	122	511	**633**
	%	13.6	18.6	**17.4**
Broken pm	**n**	53	44	**97**
	%	5.9	1.6	**2.7**
Root only	**n**	37	63	**100**
	%	4.1	2.3	**2.8**
Congenitally absent	**n**	0	6	**6**
	%	-	0.2	**0.2**
Not erupted	**n**	12	56	**68**
	%	1.3	2.0	**1.9**
Isolated tooth	**n**	47	135	**182**
	%	5.2	4.9	**5.0**
Total positions observable	**n**	**532**	**1728**	**2260**
	%	**59.6**	**63.1**	**62.3**
Total teeth observable	**n**	**214**	**727**	**941**
	%	**24.0**	**26.6**	**25.9**

Table 8.9 General preservation of teeth (total = possible tooth socket positions: New Kingdom N=892, post-New Kingdom N=2738, total N=3630)

8.5.2. Dental attrition

8.5.2.i. General remarks

Mean values were calculated based on the number of teeth observed for dental attrition for each tooth type and are presented separately for maxillary (see Table 8.10) and mandibular teeth (see Table 8.11). Anterior teeth were scored according to Smith (1984) with values ranging between 1 and 8, while molars were scored with values ranging between 4 and 40 according to Scott (1979). Only molars with a complete crown and all four sections observable were included in the analysis. Mean values were calculated for the entire sample as well as for each age category seperately.

8.5.2.ii. Maxillary Teeth

Attrition of teeth was generally rather high for the upper (see Figures III.70, III.75) and lower dentition in both the New Kingdom and post-New Kingdom samples even though attrition generally tended to be higher in New Kingdom anterior teeth and post-New Kingdom molars. No clear pattern in the difference between the time periods was observable. However, the New Kingdom sample size is rather low. In the maxillary teeth, in the young adult category, dental attrition is higher in the post-New Kingdom period for the anterior teeth and 3rd molars. The opposite holds true for the middle adult individuals, where attrition is lower in the anterior teeth during the post-New Kingdom period, and slightly higher than during the New Kingdom in the 1st and 3rd molars. In the old adult category an insufficient number of teeth were observable to allow for any more comprehensive conclusions.

8.5.2.iii. Mandibular teeth

Dental attrition in the mandibular teeth (see Table 8.11) again does not differ significantly between the time periods even though it was generally slightly higher during the post-New Kingdom period with the exception of the 3rd molar. Within age groups, marked differences were only observed in middle adults, with higher attrition in the New Kingdom P4 and M1, even though this comparison is based on one New Kingdom and two post-New Kingdom individuals. Rates do not appear to rise very much from the young adult to the middle adult group, which is likely to be explained by the increasing degree of AMTL in older individuals.

		I1		I2		C		P3		P4		M1		M2		M3	
		NK	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**
Sub-adults	**n**	0	6	1	5	1	3	1	6	1	5	1	10	1	4	1	4
	mA	-	2.0	2.0	2.0	2.0	2.0	-	2.0	-	2.0	6.5	9.5	-	5.3	-	4.0
Young Adults	**n**	9	18	8	18	9	19	7	20	8	26	7	14	5	11	7	14
	mA	4.3	5.4	3.2	4.4	4.3	5.0	4.9	5.5	5.0	5.2	25.1	20.4	15.7	14.1	9.2	12.0
Middle adults	**n**	2	6	0	8	3	7	1	9	2	5	2	5	6	8	2	7
	mA	7.0	6.7	-	6.6	8.0	6.4	8.0	6.3	7.0	6.2	24.0	24.2	26.0	16.8	10.0	13.3
Old adults	**n**	0	3	0	0	0	2	0	0	0	3	0	0	0	1	0	1
	mA	-	7.3	-	-	-	6.5	-	-	-	5.8	-	-	-	14.0	-	7.0
Adult indet	**n**	3	1	2	2	3	5	1	5	2	3	1	4	6	4	2	5
	mA	2.7	5.0	2.0	5.0	2.8	5.0	2.0	4.5	4.0	4.5	30.0	23.8	26.0	11.5	8.5	12.4
Total	**n**	**14**	**39**	**11**	**33**	**15**	**36**	**9**	**37**	**12**	**41**	**11**	**33**	**7**	**28**	**11**	**31**
	mA	**4.4**	**5.4**	**2.9**	**4.6**	**4.7**	**5.1**	**5.0**	**5.3**	**5.2**	**4.9**	**21.9**	**17.8**	**17.8**	**13.6**	**9.6**	**11.0**

Table 8.10 Mean dental attrition of the maxillary teeth (left and right side pooled, n= Number of individuals with tooth type preserved, mA=mean attrition)

		I1		I2		C		P3		P4		M1		M2		M3	
		NK	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**	**NK**	**pNK**
Sub-adults	n	0	6	0	3	0	3	0	4	0	0	1	5	0	6	0	1
	mA	-	1.7	-	2.0	-	3.0	-	4.0	-	-	4.0	9.5	-	6.8	-	8.0
Young Adults	n	12	25	8	28	9	27	3	19	4	16	8	12	10	14	6	17
	mA	4.0	6.5	3.6	5.8	4.0	5.5	3.5	4.7	3.3	5.0	26.0	29.5	16.7	20.3	14.2	14.7
Middle adults	n	0	13	2	12	2	12	3	6	2	7	1	2	0	4	2	5
	mA	-	6.8	7.5	6.6	6.0	6.7	7.0	7.0	7.5	5.8	35.0	22.0	-	20.5	13.5	18.4
Old adults	n	0	7	0	6	0	5	0	3	0	3	0	1	0	3	1	1
	mA	-	7.6	-	7.0	-	6.7	-	6.5	-	5.8	-	30.0	-	20.3	18.0	14.0
Adult indet	n	0	1	0	2	0	1	1	2	0	1	1	3	6	4	2	3
	mA	-	4.0	-	4.0	-	7.0	6.0	6.0	-	7.0	18.0	20.5	21.0	25.0	15.5	23.5
Total	n	**12**	**49**	**10**	**51**	**7**	**48**	**7**	**31**	**6**	**27**	**11**	**23**	**11**	**31**	**11**	**27**
	mA	**4.0**	**6.1**	**4.4**	**5.9**	**4.8**	**5.8**	**5.3**	**5.4**	**4.1**	**5.3**	**24.5**	**23.2**	**17.0**	**18.4**	**15.3**	**15.7**

Table 8.11 Mean dental attrition values for mandibular teeth (left and right side pooled, n= Number of individuals with tooth type preserved, mA=mean attrition)

8.5.3. Caries

Caries prevalence rates were calculated according to the number of teeth preserved for observation (see Figure 8.6, Table 8.12) as well as based on the number of individuals (see Figure 8.7, Table 8.13)

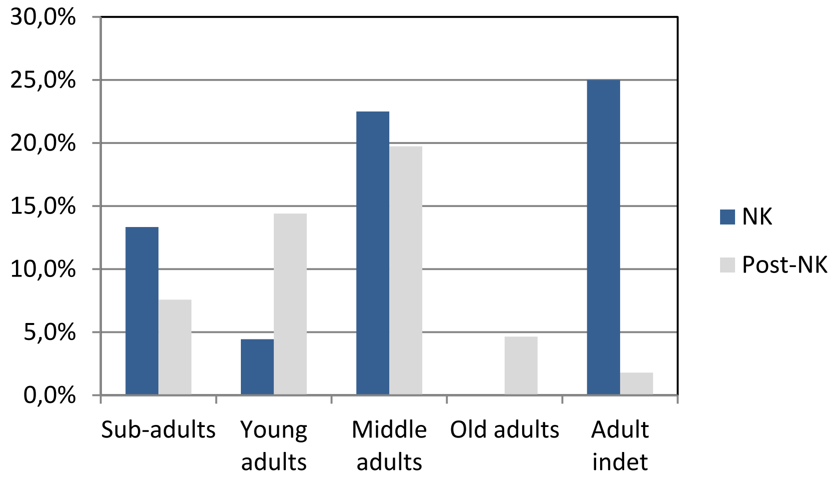

Figure 8.6 Caries prevalence according to number of teeth affected, by age group

		NK	Post-NK	Total
Sub-adults	**n/N**	2/15	10/131	12/146
	%	13.3	7.6	8.2
Young Adults	**n/N**	**6/134**	**52/357**	58/491
	%	**4.5****	**14.6****	11.8
Middle adults	**n/N**	**9/139**	**30/148**	39/287
	%	**6.5**	**20.3**	13.6
Old adults	**n/N**	0/3	2/42	2/45
	%	-	4.8	4.4
Adult indet	**n/N**	4/16	1/56	5/72
	%	25.0	1.8	6.9
Total	**n/N**	21/207	95/734	116/941
	%	10.1	12.9	12.3

Table 8.12 Frequencies of caries calculated by number of teeth preserved in each category

Overall, prevalence rates based on the number of teeth observed (see Table 8.12) are equally high during the New Kingdom (10.1%) and post-New Kingdom periods (12.9%), with only a slight increase during the later time period. However, when broken down by age category, the percentage of teeth affected by caries is significantly higher for both young and middle adult individuals during the post-New Kingdom period (young adults:

χ^2=9.628, df=1, p=0.002; middle adults χ^2=11.618; df=1; p=0.001). The highest rates were observed in the post-New Kingdom middle adult individuals.

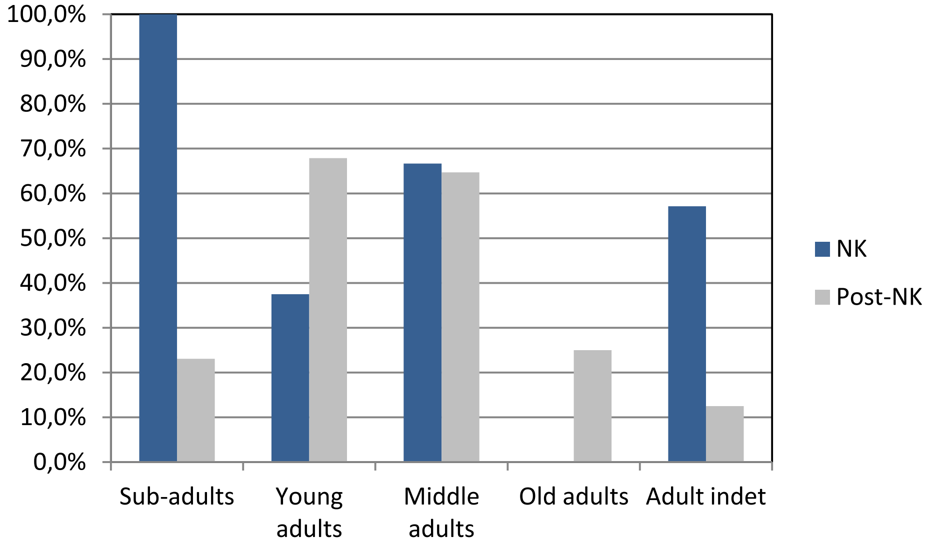

Figure 8.7 Individuals affected by caries

		NK	post-NK	total
Sub-adults	**n/N**	1/1	3/13	4/14
	%	100.0	23.1	28.6
Young Adults	**n/N**	3/8	19/28	22/36
	%	37.5	67.9	61.1
Middle adults	**n/N**	4/6	11/17	15/23
	%	66.7	64.7	65.2
Old adults	**n/N**	0/1	1/4	1/5
	%	-	25.0	20.0
Adult indet	**n/N**	4/7	1/8	5/15
	%	57.1	12.5	33.3
Total	**n/N**	12/23	35/70	47/93
	%	52.2	50.0	50.5

Table 8.13 Number of individuals affected by caries

Prevalence rates for the number of individuals affected by caries were calculated for all individuals with at least three teeth observable or one tooth affected by caries (see Figure 8.7, Table 8.13). 93 individuals could be included in this analysis. Caries was generally very common throughout the sample (see Table 8.13, Figure III.70). Frequencies are very similar in both time periods for the overall sample at 52.2% during the New Kingdom and 50.0% during the post-New Kingdom period. It already affected 28.6% of sub-adult individuals with permanent teeth. This rate doubled in young adults (61.1% for the overall sample). In middle adults it only slightly increased, even though the high rate of AMTL in middle and old adult individuals possibly obscured this rate. When comparing age groups seperately, major differences were only observed for young adult individuals, showing an increase of 30.4% during the post-New Kingdom period. However, this difference is not statistically significant (χ^2=2.413, df=1, p=0.217). In middle adult individuals, caries rates are very similar at 66.7% and 66.4% respectively.

8.5.3.i. Sex-related differences

		NK	Post-NK	Total
Female	**n/N**	9/91	47/399	56/391
	%	9.9	15.7	14.3
Male	**n/N**	9/95	32/278	41/373
	%	9.5	11.5	11.0
Indifferent	**n/N**	1/8	16/304	17/120
	%	12.5	5.3	14.2
Total	**n/N**	19/194	95/690	114/884
	%	9.8	13.8	12.9

Table 8.14 Caries frequencies (according to number of teeth affected) for males and females

Frequencies were also compared between male and female adult teeth (see Table 8.14) and according to individuals affected (see Table 8.15). Caries prevalence according to tooth type affected in females is only marginally higher than in male individuals during both time periods (New Kingdom: +0.4%. post-New Kingdom: +4.2). This difference is more marked during the post-New Kingdom period (11.5% in males and 15.7% in females). The overall increase in caries rates during the post-New Kingdom period is also seen when analysed for each sex seperately. While in females an increase of 5.8% was observed, the frequency of male carious teeth only increased by 2%.

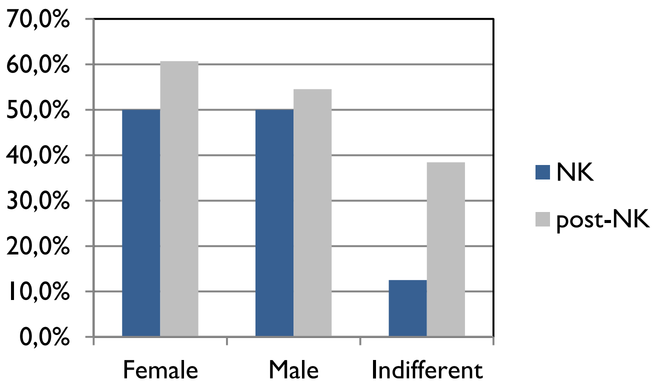

Figure 8.8 Caries in female and male individuals

		NK	Post-NK	Total
Female	**n/N**	5/10	17/28	22/38
	%	50.0	60.7	57.9
Male	**n/N**	4/8	12/22	16/30
	%	50.0	54.5	53.3
Indifferent	**n/N**	1/8	5/13	6/21
	%	12.5	38.5	28.6
Total	**n/N**	11/22	34/63	45/85
	%	50.0	54.0	52.9

Table 8.15 Caries frequencies for male and female individuals

When calculated on an individuals affected basis (see Table 8.15, Figure 8.8), there is almost no difference between males and females during the New Kingdom (females: 50.0%, males: 50.0%) and post-New Kingdom periods (females: 60.7%, males: 59.1%). Compared within the sex groups, there is again an increase during the post-New Kingdom period both for female and male individuals.

8.5.3.ii. Differences between tooth type

Caries prevalence was also calculated for each tooth type seperately based on the number of teeth available for each type with antimeres combined. The results are presented for maxillary (see Figure 8.9 and Table 8.16) and mandibular teeth (see Figure 8.10 and Table 8.17). Caries was generally most frequent in the molars and pre-molars in both upper and lower dentitions. Anterior teeth were less commonly affected in both time periods. Premolars were more commonly affected in the maxilla. As for the overall sample, the lack of carious incisors in the maxilla and mandible during the New Kingdom period, in contrast to more common involvement of this tooth type during the post-New Kingdom, is notable. However, New Kingdom caries rates in the molars exceed those of the post-New Kingdom slightly, except for the upper and lower 2nd molars and lower 3rd molars where they are higher during the post-New Kingdom period.

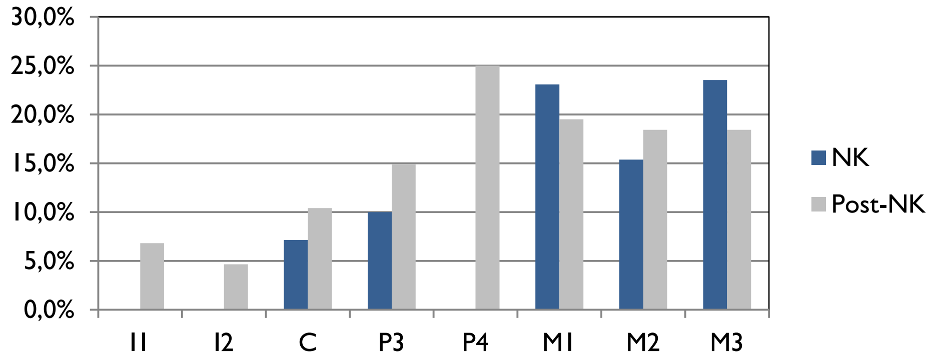

Figure 8.9 Comparison between caries rates for each tooth type (left and right combined)

Table 8.16 (below): Caries frequencies for maxillary teeth (left and right side combined)

		I1		I2		C		P1		P2		M1		M2		M3	
		NK	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**
Sub-adults	**n/N**	0/0	2/8	0/1	1/7	0/2	0/6	0/1	1/7	0/2	1/9	1/2	2/11	0/0	0/5	0/0	0/3
	%	-	25.0	-	14.3	-	-	-	14.3	-	11.1	50.0	18.2	-	-	-	-
Young Adults	**n/N**	0/10	1/21	0/9	0/22	1/8	3/26	1/8	3/26	0/9	9/28	1/8	5/18	1/8	2/16	0/8	4/18
	%	-	4.8	-	-	12.5	11.5	12.5	11.5	-	32.1	12.5	27.8	12.5	12.5	-	22.2
Middle adults	**n/N**	0/5	0/11	0/3	1/12	0/3	2/10	0/1	2/8	0/2	3/7	1/3	1/8	1/3	5/11	2/3	2/10
	%	-	-	-	8.3	-	20.0	-	25.0	-	42.9	33.3	12.5	33.3	45.5	66.7	20.0
Old adults	**n/N**	0/0	0/3	0/0	0/0	0/0	0/2	0/0	1/1	0/0	0/4	0/0	0/1	0/0	0/1	0/1	0/1
	%	-	-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-
Adult indet	**n/N**	0/1	0/1	0/0	0/2	0/1	0/4	0/0	0/5	0/0	0/4	0/0	0/3	0/2	0/5	2/5	1/6
	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.0	16.7
Total	**n/N**	**0/16**	**3/44**	**0/13**	**2/43**	**1/14**	**5/48**	**1/13**	**7/47**	**0/13**	**13/52**	**3/13**	**8/41**	**2/13**	**7/38**	**4/17**	**7/38**
	%	**-**	**6.8**	**-**	**4.7**	**7.1**	**10.4**	**10.0**	**14.9**	**-**	**25.0**	**23.1**	**19.5**	**15.4**	**18.4**	**23.5**	**18.4**

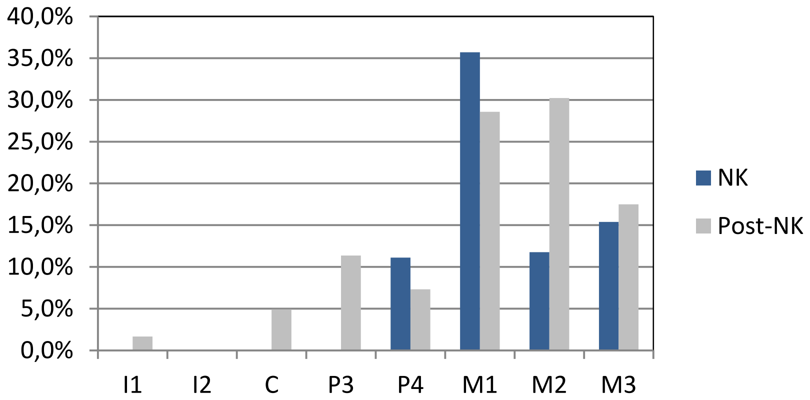

Figure 8.10 (above) and Table 8.17 (below) Caries frequencies for mandibular teeth (left and right side combined)

		I1		I2		C		P1		P2		M1		M2		M3	
		NK	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**
Sub-adults	**n/N**	0/0	0/15	0/0	0/11	0/1	0/9	0/1	0/6	0/1	0/9	1/2	3/12	0/2	0/7	0/0	0/6
	%	-	-	-	-	-	-	-	-	-	-	50.0	25.0	-	-	-	-
Young Adults	**n/N**	0/13	0/25	0/9	0/28	0/6	2/31	0/6	3/21	0/5	2/19	1/10	6/16	1/11	8/20	0/6	4/22
	%	-	-	-	-	-	6.5	-	14.3	-	10.5	10.0	37.5	9.1	40.0	-	18.2
Middle adults	**n/N**	0/1	1/10	0/3	0/13	0/1	1/15	0/1	2/10	1/3	1/7	2/1	1/2	1/2	4/7	1/4	3/7
	%	-	10.0	-	-	-	6.7	-	20.0	33.3	14.3	100.0	50.0	50.0	57.1	25.0	42.9
Old adults	**n/N**	0/0	0/7	0/0	0/4	0/1	0/4	0/0	0/4	0/0	0/4	0/0	0/2	0/0	1/3	0/1	0/1
	%	-	-	-	-	-	-	-	-	-	-	-	-	-	33.3	-	-
Adult indet	**n/N**	0/0	0/3	0/0	0/3	0/1	0/3	0/1	0/3	0/0	0/2	1/1	0/3	0/2	0/6	1/2	0/4
	%	-	-	-	-	-	-	-	-	-	-	100.0	-	-	-	50.0	-
Total	**n/N**	**0/14**	**1/60**	**0/12**	**0/59**	**0/10**	**3/61**	**0/9**	**5/44**	**1/9**	**3/41**	**5/14**	**10/35**	**2/17**	**13/43**	**2/13**	**7/40**
	%	**-**	**1.7**	**-**	**-**	**-**	**4.9**	**-**	**11.4**	**11.1**	**7.3**	**35.7**	**28.6**	**11.8**	**30.2**	**15.4**	**17.5**

8.5.4. AMTL

Antemortem tooth loss (AMTL, see Figures III.73, III.74) was analysed for all individuals with dentitions preserved. Prevalence rates were calculated for the total number of tooth positions available for study (see Table 8.18) as well as for all individuals with at least three tooth positions observable (see Table 8.19).

8.5.4.i. Age-related comparison of AMTL

		NK	post-NK	total
Sub-adults	**n/N**	0/0	7/73	7/73
	%	-	9.6	9.6
Young Adults	**n/N**	14/203	185/669	199/872
	%	6.9**	27.7**	22.8
Middle adults	**n/N**	78/165	177/405	255/570
	%	47.3	43.7	44.7
Old adults	**n/N**	4/6	74/156	78/162
	%	66.7	47.4	48.1
Adult indet	**n/N**	26/85	68/186	94/271
	%	30.6	36.6	34.7
Total	**n/N**	**122/459**	**511/1489**	**633/1948**
	%	**26.6****	**34.3****	**32.5**

Table 8.18 AMTL frequencies based on the total number of tooth positions observable (**difference is statistically significant at a 0.95% confidence level)

The prevalence of AMTL analysed according to the number of tooth positions observable (see Table 8.18) is significantly higher during the post-New Kingdom period (χ^2=9.579, df=1, p=0.002). When analysed for each age category separately, the difference is strongest in the young adult category with 20.6% more in the post-New Kingdom sample, which is statistically significant (χ^2=37.797, df=1, p=0.000).

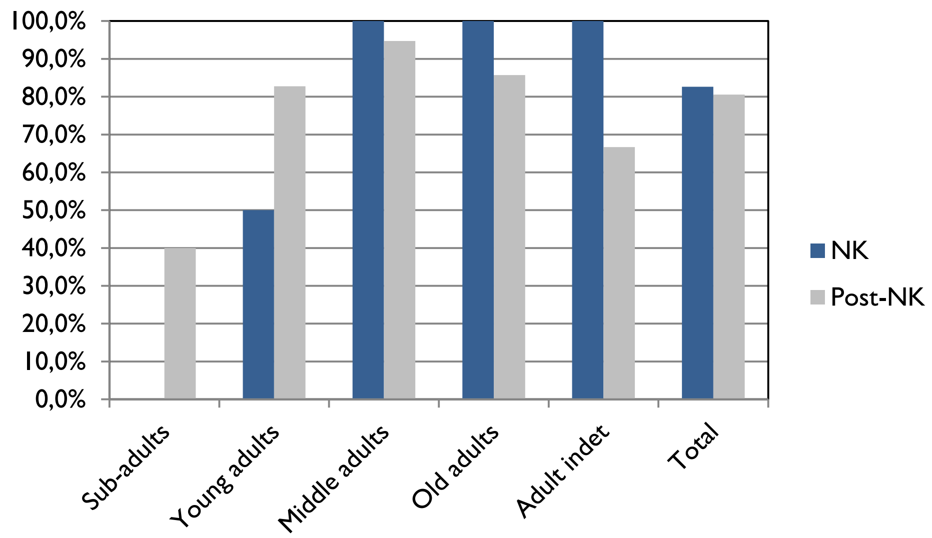

Figure 8.11 Age-related comparison of individuals with AMTL

		NK	post-NK	total
Sub-adults	**n/N**	0/0	2/5	2/5
	%	-	40.0	40.0
Young Adults	**n/N**	4/8	24/29	28/37
	%	50.0**	82.8**	75.7
Middle adults	**n/N**	8/8	18/19	26/27
	%	100.0	94.7	96.3
Old adults	**n/N**	0/0	6/7	6/7
	%	-	85.7	85.7
Adult indet	**n/N**	7/7	8/12	15
	%	100.0	66.7	81.1
Total	**n/N**	**19/23**	**58/72**	**77**
	%	**82.6**	**80.6**	**81.1**

Table 8.19 Frequencies of individuals with antemortem tooth loss (**difference is statistically significant at the 0.95% confidence level)

Included in the analysis of AMTL prevalence, based on individuals affected, were all individuals with at least three tooth positions observable, or individuals with less than three but at least one tooth lost antemortem (see Table 8.19, Figure 8.11). AMTL was again very common, affecting 82.6% of New Kingdom and 80.6% post-New Kingdom individuals. It was already present in two individuals aged between 15–18 years. The comparison revealed no significant differences between the New Kingdom and post-New Kingdom period for the overall sample. Only within the young adult age group, a major increase during the post-New Kingdom period was observed. The large difference did not produce statistical significance through a chi-square (χ^2=3.655, df=1, p=0.056) or Fisher's Exact Test (p=0.078) even though this may again be due to the small sample size for the New Kingdom.

8.5.5. AMTL per tooth type

AMTL was further analysed by tooth position. The results for maxillary and mandibular teeth are presented separately, with antimeres of each tooth pooled. Table 8.20 and Figure 8.12 show the results for upper teeth. Frequencies were generally high for all tooth positions, even though the molars were more commonly affected than the anterior teeth. In diachronic comparison, while in the anterior tooth rates were higher in the New Kingdom sample, post-New Kingdom rates were higher in molars.

Table 8.21 and Figure 8.13 present the results for the mandibular teeth. In contrast to the maxilla, the difference between New Kingdom and post-New Kingdom frequencies is far greater. With the exception of I1, frequencies in all teeth were higher in the post-New Kingdom period for the overall sample. Within age groups, some tooth positions scored higher in the New Kingdom period even though this is again problematic due to the small sample size in the New Kingdom teeth.

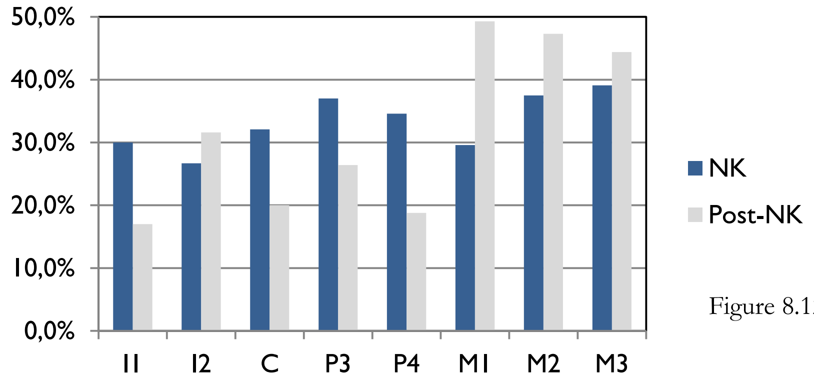

Figure 8.12 AMTL in the maxilla (left and right combined)

		I1		I2		C		P1		P2		M1		M2		M3	
		NK	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**
Sub-adults	**n/N**	0/0	0/4	0/0	0/2	0/0	0/3	0/0	0/4	0/0	0/4	0/0	0/1	0/0	0/3	0/0	0/3
	%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Young Adults	**n/N**	0/12	7/42	0/12	12/45	2/13	5/46	1/12	7/42	1/12	3/42	1/13	19/38	2/13	17/38	2/12	14/38
	%	-	16.7	-	26.7	15.4	10.9	8.3	16.7	8.3	7.1	7.7	50.0	15.4	44.7	16.7	41.2
Middle adults	**n/N**	4/10	7/25	6/10	11/26	7/13	5/25	9/13	8/22	8/12	7/20	5/10	8/17	6/8	8/17	6/8	7/15
	%	40.0	28.0	46.2	42.3	53.8	20.0	69.2	36.4	66.7	35.0	50.0	47.1	75.0	53.3	75.0	58.3
Old adults	**n/N**	0/0	1/10	0/0	5/10	0/0	5/10	0/0	5/9	0/0	3/9	1/1	6/8	1/1	7/8	0/1	5/8
	%	-	10.0	-	50.0	-	50.0	-	55.6	-	33.3	100.0	75.0	100.0	87.5	-	83.3
Adult indet	**n/N**	5/8	2/19	2/8	2/12	0/4	4/11	0/2	3/10	0/2	3/10	1/3	4/11	0/2	3/10	1/2	2/9
	%	62.5	10.5	50.0	16.7	-	36.4	-	30.0	-	30.0	33.3	36.4	-	30.0	50.0	22.2
Total	**n/N**	**9/30**	**17/100**	**8/30**	**30/95**	**9/28**	**19/95**	**10/27**	**23/87**	**9/26**	**16/85**	**8/27**	**37/74**	**9/24**	**35/74**	**9/23**	**28/63**
	%	**30.0**	**17.0**	**26.7**	**31.6**	**32.1**	**20.0**	**37.0**	**26.4**	**34.6**	**18.8**	**29.6**	**49.3**	**37.5**	**47.3**	**39.1**	**44.4**

Table 8.20 AMTL per tooth type in the upper dentition

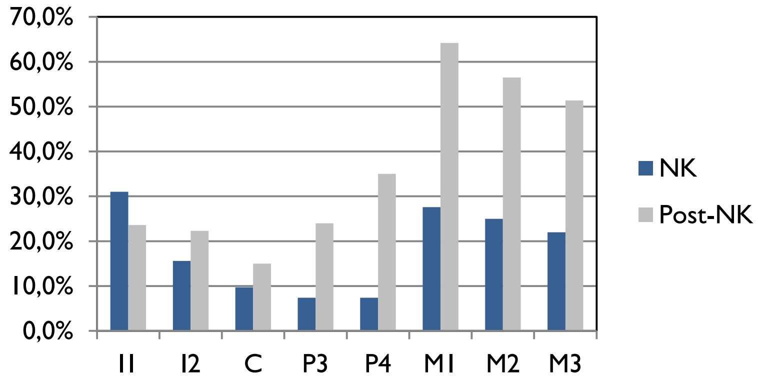

Figure 8.13: Comparison of AMTL rates in the mandibular teeth between time periods and tooth types (all age ranges combined)

		I1		I2		C		P1		P2		M1		M2		M3	
		NK	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**	**NK**	**post-NK**
Sub-adults	**n/N**	0/4	0/7	0/4	0/8	0/4	0/6	0/4	1/6	0/4	0/6	0/0	1/7	0/0	3/7	0/0	2/6
	%	-	-	-	-	-	-	-	16.7	-	-	-	14.3	-	42.9	-	33.3
Young Adults	**n/N**	1/13	5/40	2/15	5/40	2/15	2/40	0/12	8/42	012	10/42	0/12	26/45	0/12	25/47	0/12	20/46
	%	7.7	12.5	13.3	12.5	13.3	5.0	-	-	-	23.8	-	57.8	-	53.2	-	43.5
Middle adults	**n/N**	6/12	12/31	3/11	8/30	1/10	6/29	1/9	6/29	1/0	16/30	5/10	27/32	4/5	21/31	5/9	20/31
	%	50.0	38.7	27.3	26.7	10.0	20.7	11.1	11.1	11.1	53.3	50.0	84.4	80.0	67.7	55.6	64.5
Old adults	**n/N**	0/0	1/10	0/0	2/10	0/0	2/11	0/0	3/11	0/0	5/11	1/1	9/11	1/1	8/11	0/1	7/11
	%	-	10.0	-	20.0	-	18.2	-	27.3	-	45.5	100.0	81.8	100.0	72.7	0.0	63.6
Adult indet	**n/N**	2/4	7/18	0/4	8/15	0/4	5/14	1/4	6/12	1/4	4/11	2/6	5/11	1/6	4/12	1/5	5/11
	%	50.0	38.9	-	53.3	-	35.7	25.0	25.0	25.0	36.4	50.0	45.5	25.0	33.3	25.0	45.5
Total	**n/N**	**9/29**	**25/106**	**5/32**	**23/103**	**3/31**	**15/100**	**2/27**	**24/100**	**2/26**	**35/100**	**8/29**	**68/106**	**6/24**	**61/108**	**6/27**	**54/105**
	%	**31.0**	**23.6**	**15.6**	**22.3**	**9.7**	**15.0**	**7.4**	**24.0**	**7.7**	**35.0**	**27.6**	**64.2**	**25.0**	**56.5**	**22.0**	**51.4**

Table 8.21 AMTL per tooth type in the lower dentition

8.5.6. Periapical lesions

		NK	Post-NK	total
Sub-adults	**n/N**	0/21	2/74	2/95
	%	-	2.7	2.1
Young Adults	**n/N**	8/203	67/675	75/878
	%	3.9**	9.6**	8.5
Middle adults	**n/N**	33/166	39/408	72/574
	%	19.9**	9.6**	12.5
Old adults	**n/N**	0/6	21/159	21/165
	%	-	13.2	12.7
Adult indet	**n/N**	8/85	15/186	23/271
	%	9.4	8.1	8.5
Total	**n/N**	**49/460**	**144/1502**	**193/1962**
	%	**10.7**	**9.6**	**9.8**

Table 8.22 Periapical lesion frequencies calculated per position observable (**=statistically significant at the 0.95% confidence level)

The prevalence of periapical lesions (see Figures III.71, III.72) in the permanent dentition was calculated according the number of tooth positions within the dentition observable (see Table 8.22) and the number of individuals with at least three positions preserved (see Table 8.23, Figure 8.14). Sub-adults younger than 12 years were not included the analysis. The juvenile group (13–20 years) was also analysed, because 2.7% of the dentitions within this subsample were affected by periapical lesion formation. When calculated on the basis of total number of lesions against total number of tooth positions observable no major differences were observed for the overall sample, with a 10.7% prevalence in the New Kingdom and 9.6% in the post-New Kingdom sample. When compared for each age category seperately, the New Kingdom young adults and the post-New Kingdom middle adults showed a higher prevalence than their respective comparative sample. Both differences proved to be statistically significant (young adults χ^2=7.156, df=1, p=0.007, middle adults 4.361, df=1, p=0.027). Lesions were already observable in the sub-adult group, with 2.7% of the sample being affected.

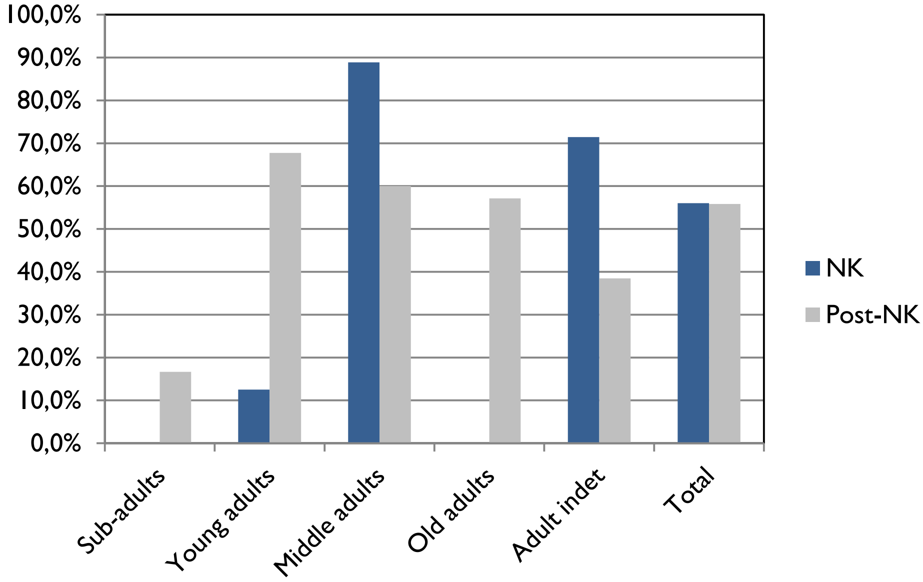

Figure 8.14 Individuals with periapical lesions

		NK	post-NK	Total
Sub-adults	**n/N**	0/0	1/6	**1/6**
	%	-	16.7	**16.7**
Young Adults	**n/N**	1/8	20/31	**22/39**
	%	12.5**	67.7**	**56.4**
Middle adults	**n/N**	8/9	12/20	**20/29**
	%	88.9	60.0	**69.0**
Old adults	**n/N**	0/1	4/7	**4/8**
	%	-	57.1	**50.0**
Adult indet	**n/N**	5/7	5/13	**10/20**
	%	71.4	38.5	**50.0**
Total	**n/N**	**14/25**	**43/77**	**57/102**
	%	**56.0**	**55.8**	**55.9**

Table 8.23 Individuals with periapical lesions (** indicates significance at the 0.95% confidence level)

When analysed according to individuals affected by lesions, the frequencies are again similar when analysed for the entire sample (see Figure 8.14, Table 8.23). However, major differences were observed within age groups even though, again, results were slightly limited by the small sample size. In the young adult range, a statistically significant increase (χ^2=4.039; df=1, p=0.049, Fisher p=0.059) from 12.5% during the New Kingdom to 67.7% in the post-New Kingdom period was observed. In middle adults, rates were slightly higher in the New Kingdom period. Within the old adult range, only one individual could be analysed in the New Kingdom period, and thus the rate of 0.0% is not representative.

8.5.6.i. Frequencies of periapical lesions in relationship to tooth position

The occurrence of periapical lesion was further analysed with regard its location within the dentition. The results are presented seperately for the maxilla (see Figure 8.15, Table 8.24) and mandible (see Figure 8.16, Table 8.25). In the maxilla, lesions were more common in the anterior teeth in both time periods. The highest frequencies for the pooled age sample were observed in post-New Kingdom canines (27.3%) and New Kingdom 3rd molars (20.7%). In diachronic comparison, the rates for the anterior teeth and premolars (except I^2) were higher in the post-New Kingdom period, while in the molars they were significantly higher in the post-New Kingdom period. When broken down into age categories, periapical lesions had already affected sub-adult maxillae, with a lesion observed on one post-New Kingdom P^3. Prevalence is already marked in young adults, with slightly higher values in the post-New Kingdom period.

Distribution in the mandibular teeth was different both between tooth positions as well as between time periods (see Table 8.25, Figure 8.16). While in New Kingdom individuals, significantly higher rates were observed in the premolars and M1 than in any other teeth, rates are more evenly distributed in the post-New Kingdom teeth. With the exception of the canine and 1st incisor, frequencies were generally higher in the New Kingdom. New Kingdom young adult individuals were by far less commonly affected than their post-New Kingdom equivalent, with no periapical lesions in the mandibular teeth and low values in the maxillary anterior teeth. In middle adults, an increase is noted in the New Kingdom individuals, while frequencies appear to decrease in post-New Kingdom individuals. Comparison of old adult individuals is again not possible due to the low number of New Kingdom old adults

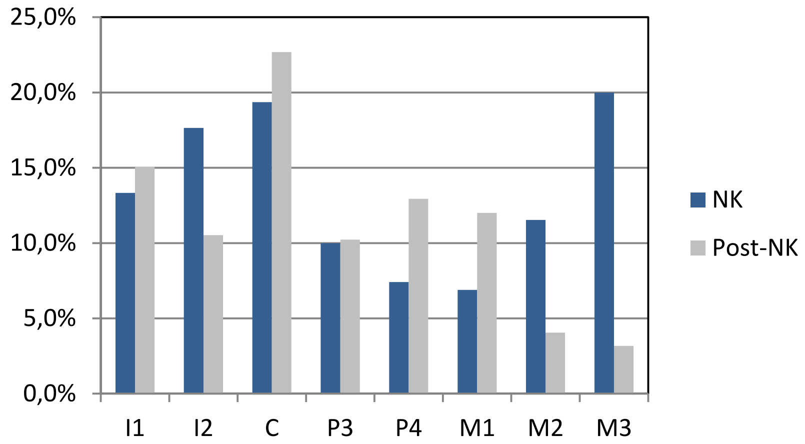

Figure 8.15 Rates for periapical lesions per tooth type

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		I1		I2		C		P3		P4		M1		M2		M3		Total	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Sub-adults	**n/N**	0/0	0/3	0/0	0/2	0/0	0/3	0/0	1/4	0/0	0/4	0/0	0/1	0/0	0/3	0/0	0/2	0/0	1/22
	%	-	-	-	-	-	-	-	25.0	-	-	-	-	-	-	-	-	-	4.5
Young Adults	**n/N**	0/12	6/43	0/13	5/45	1/13	6/47	0/12	4/43	0/12	8/42	1/13	4/38	2/13	2/38	2/12	2/34	6/100	37/329
	%	-	14.3	-	11.1	7.7	12.8	-	9.3	-	19.0	7.7	10.5	15.4	5.3	16.7	5.9	6.0	11.2
Middle adults	**n/N**	4/10	4/26	6/13	4/26	4/13	9/26	3/13	3/22	2/12	2/20	1/10	3/17	0/9	0/17	1/8	0/12	21/88	25/164
	%	40.0	15.4	46.2	15.4	30.8	34.6	23.1	13.6	16.7	10.0	10.0	17.6	-	-	12.5	-	23.9	15.2
Old adults	**n/N**	0/0	3/10	0/0	1/10	0/0	4/10	0/0	1/9	0/0	1/9	0/1	1/8	0/1	1/8	0/1	0/6	0/3	12/70
	%	-	30.0	-	10.0	-	40.0	-	11.1	-	11.1	-	12.5	-	12.5	-	-	-	17.1
Adult indet	**n/N**	0/8	1/12	0/2	0/12	1/5	3/11	0/5	0/10	0/3	0/10	0/5	1/11	1/3	0/11	2/4	0/9	4/41	5/85
	%	-	8.3	-	-	20.0	27.3	-	-	-	-	-	9.1	33.3	-	50.0	-	9.8	5.9
Total	**n/N**	**4/30**	**14/93**	**6/34**	**10/95**	**6/31**	**22/95**	**3/30**	**9/88**	**2/27**	**11/85**	**2/29**	**9/75**	**3/26**	**3/74**	**5/25**	**2/63**	**31/232**	**80/670**
	%	**13.3**	**15.1**	**17.6**	**10.5**	**19.4**	**22.7.3**	**10.0**	**10.2**	**7.4**	**12.9**	**6.9**	**12.0**	**11.5**	**4.1**	**20.7**	**3.2**	**13.4**	**11.9**

Table 8.24 Periapical lesion frequencies for each tooth type (right and left combined)

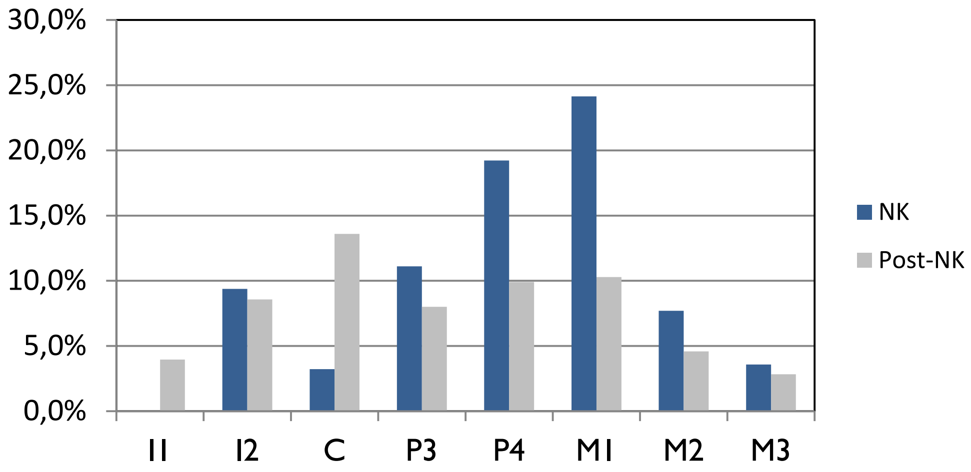

Figure 8.16 Distribution of periapical lesion frequencies in the mandibular teeth (all ages combined)

		I1		I2		C		P3		P4		M1		M2		M3		Total	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Sub-adults	n/N	0/0	0/5	0/0	0/8	0/0	1/7	0/0	0/6	0/0	0/6	0/0	0/7	0/0	0/7	0/0	0/6	0/0	1/52
	%	-	-	-	-	-	14.3	-	-	-	-	-	-	-	-	-	-		1.9
Young Adults	n/N	0/13	2/40	0/15	2/40	0/15	7/41	0/12	4/42	0/12	3/42	1/12	8/46	1/12	3/48	0/12	1/47	2/103	30/346
	%	-	5.0	-	5.0	-	17.1	-	9.5	-	7.1	8.3	17.4	8.3	6.3	-	2.1	1.9	8.7
Middle adults	n/N	0/12	1/31	1/11	2/30	1/10	2/29	1/9	2/29	3/9	4/31	4/10	1/32	1/7	1/31	1/10	1/31	12/78	14/244
	%	-	3.2	9.1	6.7	10.0	6.9	11.1	6.9	33.3	12.9	40.0	3.1	14.3	3.2	10.0	3.2	15.4	5.7
Old adults	n/N	0/0	1/10	0/0	3/12	0/0	1/12	0/0	1/11	0/0	0/11	0/1	2/11	0/1	1/11	0/1	0/11	0/4	9/89
	%	-	10.0	-	25.0	-	8.3	-	9.1	-	-	-	18.2	-	9.1	-	-	-	10.1
Adult indet	n/N	0/4	0/15	1/6	2/15	0/6	3/14	1/6	1/12	1/5	3/11	1/6	0/11	0/6	0/12	0/5	1/11	4/44	10/101
	%	-	-	16.7	13.3	-	21.4	16.7	8.3	20.0	27.3	16.7	-	-	-	-	9.1	9.1	9.9
Total	**n/N**	**0/29**	**4/101**	**2/32**	**9/105**	**1/31**	**14/103**	**2/27**	**8/100**	**4/26**	**10/101**	**6/29**	**11/106**	**2/26**	**5/109**	**1/28**	**3/106**	**22/228**	**10/832**
	%	**-**	**4.0**	**9.4**	**8.6**	**3.2**	**13.6**	**11.1**	**8.0**	**19.2**	**9.9**	**24.1**	**10.3**	**7.3**	**4.6**	**3.6**	**2.8**	**9.6**	**7.7**

Table 8.25 Frequencies of periapical lesions for each tooth type (left and right combined)

8.5.7. Dental calculus

8.5.7.i. Age-related prevalence of dental calculus

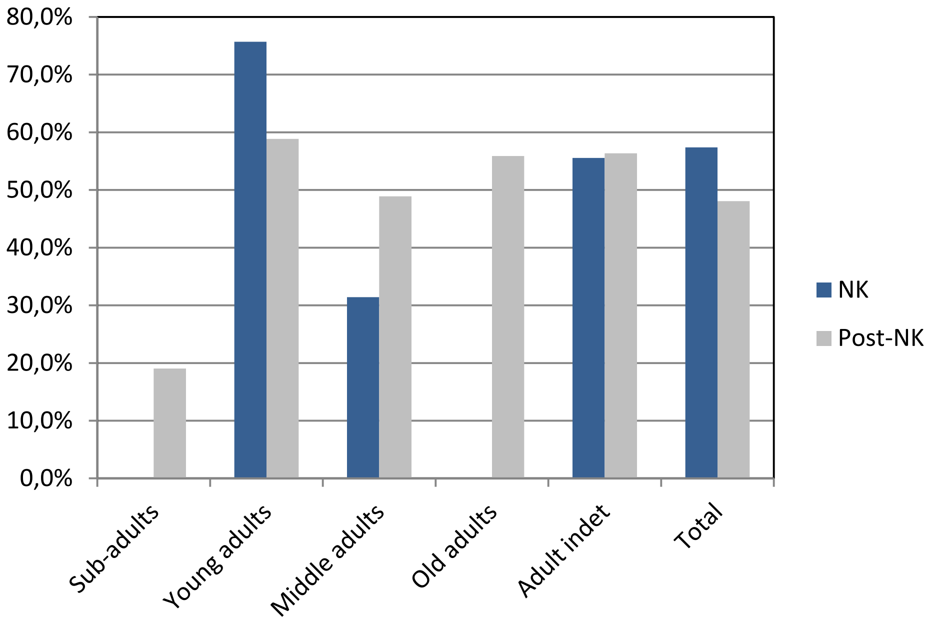

Figure 8.17 Diachronic comparison of teeth affected by dental calculus

		NK	Post-NK	NK
Sub-adults	**n/N**	0/15	76/125	**24/144**
	%	-	42.7	**17.0**
Young Adults	**n**	81/107	156/356	**237/372**
	%	75.7**	58.9**	**63.7**
Middle adults	**n**	11/35	44/90	**55/125**
	%	31.4*	48.9*	**44.0**
Old adults	**n**	0/3	19/34	**19/37**
	%	-	55.9	**51.4**
Adult indet	**n**	5/9	31/55	**36/64**
	%	55.6	56.4	**56.3**
Total	**n**	**97/169**	**274/570**	**371/739**
	%	**57.4**	**48.1**	**50.2**

Table 8.26 Teeth affected with dental calculus in relationship to age (** statistically highly significant, *significant at the 90% confidence level)

Prevalence of dental calculus was analysed for the number of teeth observable (see Figure 8.17, Table 8.26) and individuals with at least three teeth preserved (see Figure 8.18, Table 8.27). Frequencies between New Kingdom and post-New Kingdom periods were compared separately for age and sex groups (see Figure 8.20, Table 8.28). Table 8.26

presents the results of frequencies calculated for the number of teeth preserved. The number of teeth affected was slightly higher in the New Kingdom with 51.9% when compared to 48.1% in the post-New Kingdom overall sample. In young adult teeth, calculus was significantly more frequent during the New Kingdom period (χ^2=9.341, df=1, p=0.002). The opposite distribution was observed in middle adult individuals where frequencies were higher during the post-New Kingdom period, even though the difference was only significant at the 90% confidence level (χ^2=3.118, df=1, p=0.077). Dental calculus was already present in 42.7% of sub-adult permanent teeth from the post-New Kingdom period. During the New Kingdom, sub-adult teeth did not display evidence of dental calculus but the size of the sub-sample is very small with only 15 teeth (one individual) observable.

		None		Mild		Moderate		Severe		Total	
		NK	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Sub-adults	**n**	15	102	0	21	0	3	0	0	**15**	**126**
	%	100.0	81.0	-	16.7	-	2.4	-	-		
Young Adults	**n**	26	109	54	88	27	68	0	0	**107**	**265**
	%	24.3	41.1	**50.5**	**33.2**	25.2	25.7	-	-		
Middle adults	**n**	24	46	5	16	1	24	5	4	**35**	**90**
	%	68.6	51.1	14.3	17.8	2.9	26.7	14.3	4.4		
Old adults	**n**	3	15	0	12	0	7	0	0	**3**	**34**
	%	100.0	44.1	-	35.3	-	20.6	-	-		
Adult indet	**n**	4	24	5	17	0	0	0	0	**9**	**41**
	%	44.4	58.5	55.6	41.5	-	-	-	-		
Total	**n**	**72**	**296**	**64**	**154**	**28**	**116**	**5**	**4**	**169**	**570**
	%	**42.6**	**51.9**	**37.9**	**27.0**	**16.6**	**20.4**	**3.0**	**0.7**		

Table 8.27 Severity of dental calculus expressed as number of teeth affected

With regard to the severity of dental calculus, the results are tabulated in Table 8.27. If calculus was present, it was mainly expressed in mild or moderate form. In New Kingdom teeth, dental calculus was generally more often mild (37.7%) than moderate (16.6%), and severe dental calculus was only observed in 3.0% of teeth. Similarly, calculus was more often mildly expressed in the post-New Kingdom teeth, even though the difference is less pronounced, with only 27.7% mildly affected compared to 20.4% moderately affected. Within the age-groups New Kingdom young adults generally showed a much higher prevalence than post-New Kingdom young adults. This is mainly reflected in the mild calculus category where the difference is significantly different (χ^2=9.621, df=1, p=0.002). With regard to moderate calculus, the distribution is again even at 25.2% and 25.7% respectively.

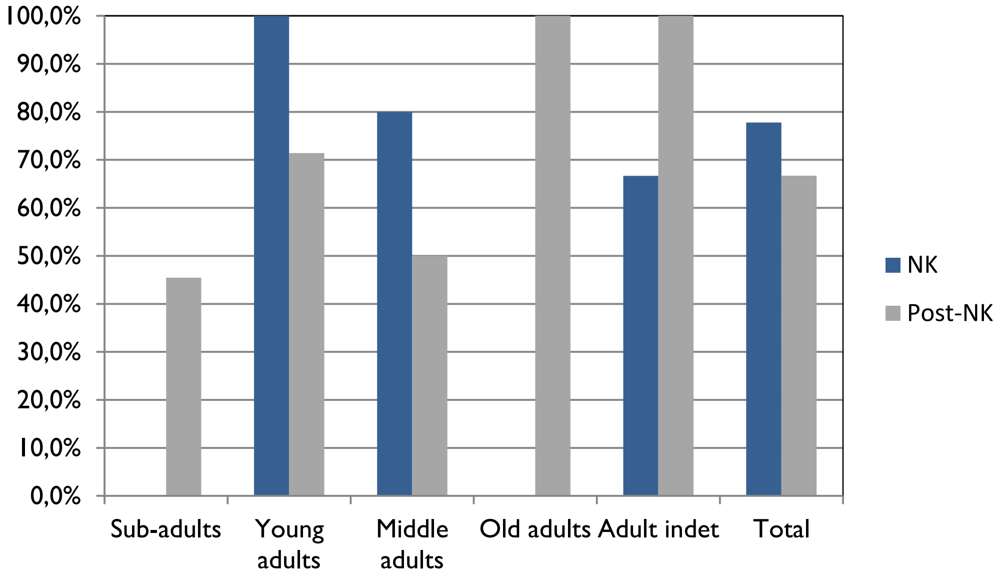

Figure 8.18 Age-related comparison of the number of individuals affected by dental calculus

		NK	Post-NK	Total
Sub-adults	**n/N**	0/0	5/11	5/11
	%	-	45.5	45.5
Young Adults	**n/N**	8/8	20/28	28/36
	%	100.0	71.4	77.8
Middle adults	**n/N**	4/5	9/18	13/23
	%	80.0	50.0	56.5
Old adults	**n/N**	0/1	3/3	3/4
	%	-	100.0	75.0
Adult indet	**n/N**	2/3	9/9	11/12
	%	66.7	100.0	91.7
Total	**n/N**	14/18	46/69	60/87
	%	77.8	66.7	69.0

Table 8.28 Age-related prevalence of dental calculus among New Kingdom and post-New Kingdom individuals

When examined at the individual level (see Figure 8.18, Table 8.28), more individuals were affected by dental calculus in the New Kingdom (77.8%) than in the post-New Kingdom period (66.7%). This tendency is also observed when broken down into age categories. Neither of these differences is statistically significant even though, again, the numbers are very small and thus statistical tests may not provide accurate results.

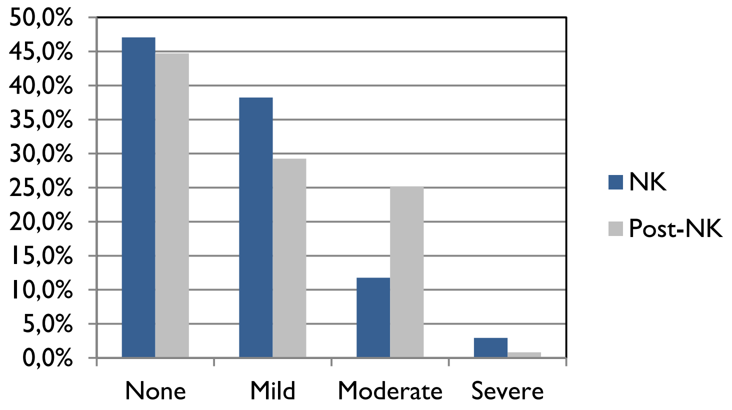

Figure 8.19 Presence and severity of dental calculus in New Kingdom and post-New Kingdom individuals

		None		Mild		Moderate		Severe		Total individuals	
		NK	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Sub-adults	**n**	1	11	0	4	0	2	0	0	**1**	**17**
	%	100.0	64.7	0.0	23.5	0.0	11.8	-	0		
Young Adults	**n**	7	22	8	17	3	15	0	1	**18**	**54**
	%	38.9	40.7	44.4	31.5	16.7	27.8	11.8	4.0		
Middle adults	**n**	4	11	3	7	1	6	1	0	**9**	**25**
	%	44.4	44.0	33.3	28.0	11.1	24.0	11.1	-		
Old adults	**n**	1	3	0	3	0	2	0	0	**1**	**8**
	%	100.0	37.5	-	37.5	-	25.0	-	-		
Adult indet	**n**	3	8	2	5	0	6	0	0	**5**	**19**
	%	60.0	26.3	40.0	26.3	-	31.6	-	-		
Total	**n**	**16**	**55**	**13**	**36**	**4**	**31**	**1**	**1**	**34**	**123**
	%	**47.1**	**44.7**	**38.2**	**29.3**	**11.8**	**25.2**	**2.9**	**0.8**		

Table 8.29 Severity of dental calculus in individuals with teeth preserved

Even though dental calculus was more prevalent during the New Kingdom period, the severity by which individuals were affected was stronger during the post-New Kingdom period (see Figure 8.19 and Table 8.29). Generally Post-New Kingdom individuals were affected by more severe dental calculus earlier than during the New Kingdom period. However, in the post-New Kingdom sample, almost half the individuals (46.9%) already suffered from moderately severe dental calculus in the young age category in contrast to only 27.3% of New Kingdom individuals.

8.5.7.ii. Sex-related prevalence

		NK	Post-NK	Total
Female	**n**	37/73	111/222	148/295
	%	50.7	50.0	50.2
Male	**n**	56/73	106/163	162/236
	%	76.7*	60.1*	68.6
Indifferent	**n**	4/8	84/110	88/118
	%	50.0	76.4	74.6
Total	**n**	103/160	250/444	398/649
	%	64.4	62.2	61.3

Table 8.30 Sex-related prevalence of dental calculus for New Kingdom and post-New Kingdom teeth (* statistically significant at 0.90% level)

Frequencies of dental calculus according to number of teeth available for study were also compared between the sexes (see Table 8.30). More teeth were affected during the New Kingdom than during the post-New Kingdom period. Differences are more pronounced in male individuals at 76.7% in the New Kingdom and 60.1% in the post-New Kingdom period. However, the difference was only statistically significant at the 90% confidence level (χ^2=3.263, df=1, p=0.071). In females, the observed frequencies were almost similar at 50.7% and 50.0% respectively.

Sex-related dental calculus rates were further calculated according to individuals affected (Figure 8.20 and Table 8.31). Prevalence was higher during the New Kingdom period for the overall sample as well as for males (100.0% vs. 73.9%) and females (75.0% vs. 64.0%). The observed differences were not statistically significant. Comparison between male and female individuals showed generally higher levels in males than in females for both time periods.

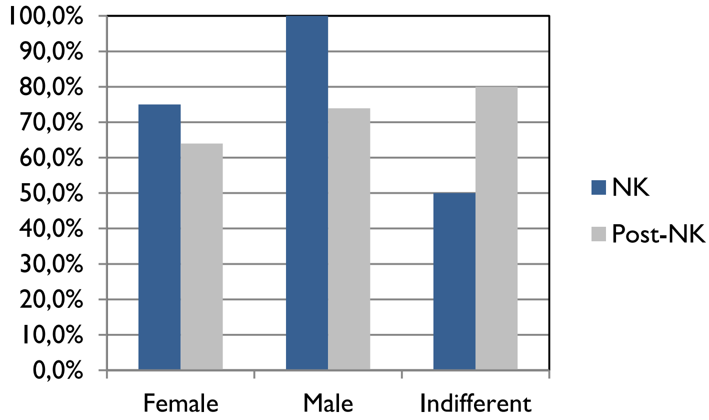

Figure 8.20 Diachronic comparison of calculus frequencies in female and male individuals

		NK	Post-NK	Total
Female	n	6/8	16/25	22/33
	%	75.0	64.0	66.7
Male	n	7/7	17/23	24/30
	%	100.0	73.9	80.0
Indifferent	n	1/2	8/10	9/12
	%	50.0	80.0	75.0
Total	n	14/17	41/58	55/75
	%	82.4	70.7	73.3

Table 8.31 Sex-related prevalence of dental calculus based on number of individuals affected

8.5.8. Periodontal disease

Periodontal disease was only analysed according to individuals affected. All individuals with at least three permanent teeth were included in the analysis. Results were calculated separately for each age category (see Figure 8.21 and Table 8.32) and for males and females (see Figure 8.23 and Table 8.33). Rates are further given for different grades of severity (see Figure 8.22, Table 8.32).

8.5.8.i. Comparison between age-groups

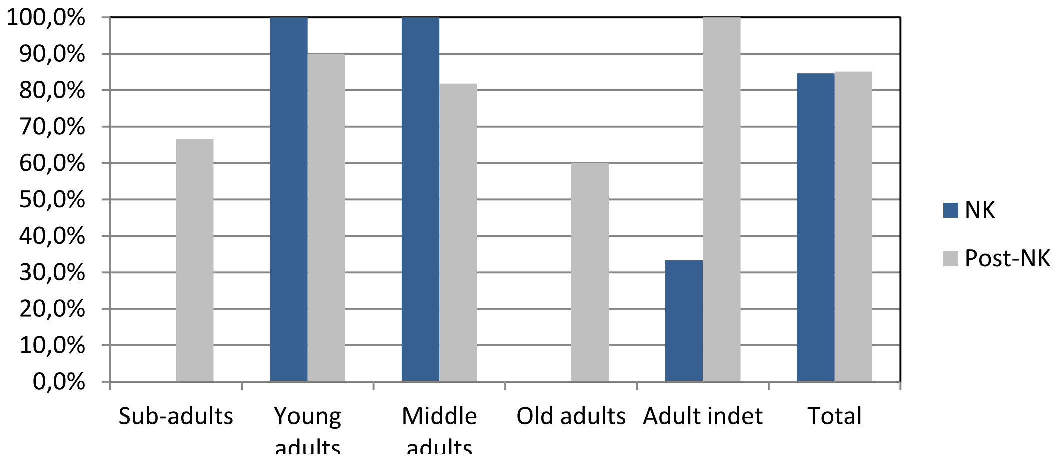

Figure 8.21 Prevalence of periodontal disease for each age category

		None		Mild		Moderate		Severe		Total periodontal disease		Total individuals	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Sub-adults	n	0	3	0	2	0	1	0	0	**0**	**2**	**0**	**3**
	%	-	100.0	-	66.7	-	33.3	-	-	**-**	**66.7**		
Young Adults	n	3	17	5	14	3	12	1	2	**6**	**18**	**6**	**20**
	%	50.0	85.0	83.3	70.0	50.0	60.0	16.7	10.0	**100.0**	**90.0**		
Middle adults	n	4	7	1	4	2	6	1	3	**4**	**9**	**4**	**11**
	%	100.0	63.6	25.0	36.4	50.0	54.5	25.0	27.3	**100.0**	**81.1**		
Old adults	n	0	0	0	2	0	3	0	0	**0**	**3**	**0**	**3**
	%	-	-	-	66.6	-	100.0	-	-	**-**	**100.0**		
Adult indet	n	3	7	1	4	0	5	0	1	**1**	**8**	**3**	**8**
	%	100.0	87.5	33.3	50.0	-	62.5	-	12.5	**33.3**	**100.0**		
Total	n	**10**	**3**	**7**	**2**	**5**	**1**	**2**	**0**	**11**	**40**	**13**	**47**
	%	**76.9**	**100.0**	**53.8**	**66.7**	**38.5**	**33.3**	**15.4**	**-**	**84.6**	**85.1**		

Table 8.32 Individuals with signs of periodontal disease

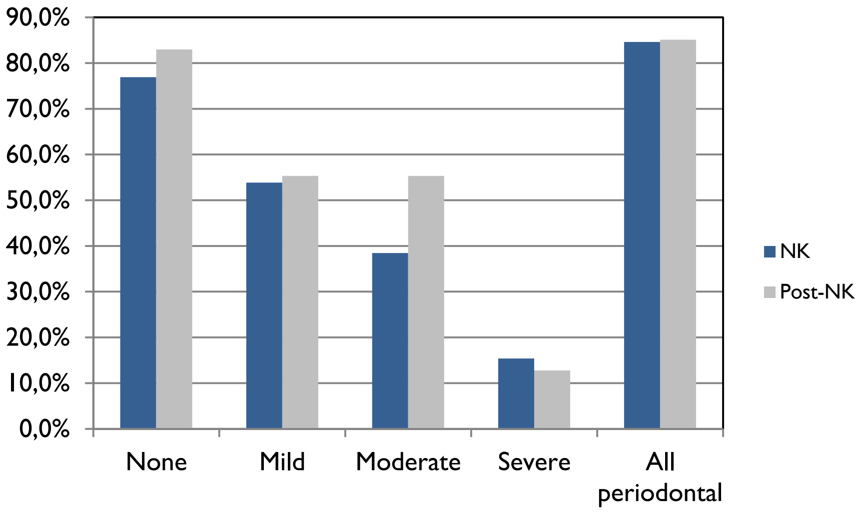

Figure 8.22 Severity of periodontal disease

With regard to general presence of periodontal disease (all grades of severity combined), Table 8.32 shows a high prevalence in both time periods and within all age ranges. Evidence for periodontal disease was already present in post-New Kingdom sub-adults. No major differences were observed between the time periods. The slight decrease in the post-New Kingdom period in young and middle adults could be due to a low sample size for the New Kingdom period. When comparing periodontal disease according to severity, again rates are quite similar in both time periods. Severe periodontal disease was rarely observed and only seen in young adults (New Kingdom: 16.7%; post-New Kingdom: 10.0%) and middle adults (New Kingdom: 25.0, post-New Kingdom: 27.3%).

8.5.8.ii. Comparison between male and female individuals

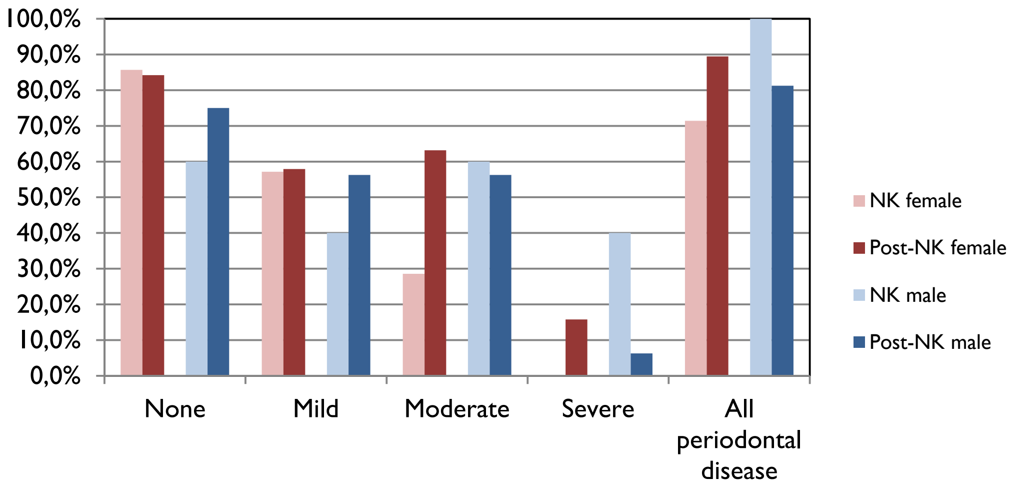

Figure 8.23 Comparison of periodontal disease in male and female individuals (all age-ranges pooled)

		None		Mild		Moderate		Severe		Total periodontal disease		Total individuals	
		NK	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Female	**n**	6	16	4	11	2	12	0	3	**5**	**17**	**7**	**19**
	%	85.7	84.2	57.1	57.9	28.6	63.2	-	15.8	**71.4**	**89.5**		
Male	**n**	3	12	2	9	3	9	2	1	**5**	**13**	**5**	**16**
	%	60.0	75.0	40.0	56.3	60.0	56.3	40.0	6.3	**100.0**	**81.3**		
Indif-ferent	**n**	1	6	1	3	0	3	0	1	**1**	**6**	**1**	**6**
	%	100.0	100.0	100.0	50.0	-	50.0	-	16.7	**100.0**	**100.0**		
Total	**n**	**10**	**34**	**7**	**23**	**5**	**24**	**2**	**5**	**11**	**36**	**13**	**41**
	%	**76.9**	**82.9**	**53.8**	**56.1**	**38.5**	**58.5**	**15.4**	**12.2**	**84.6**	**87.8**		

Table 8.33 Periodontal disease in male and female individuals

The results were further compared for male and female individuals. Figure 8.23 and Table 8.33 present the results for different grades of severity as well as for the overall presence of periodontal disease. Again, few major differences could be observed. During the New Kingdom, overall prevalence was higher in males than in females (71.4% vs. 100.0%). In contrast, during the post-New Kingdom period female rates were slightly higher at 89.5% compared to 81.3% in male individuals. While females showed an increase of 18.1% during the post-New Kingdom period, a decrease of 18.7% was observed in males. However, none of these differences proved to be statistically significant when applying a χ^2-test. Severe periodontal disease was again only rarely observed.

8.5.9. Dental enamel hypoplasias (DEH)

The prevalence of DEH was analysed for the overall number of teeth observable (see Table 8.34) as well as for the number of individuals with at least two teeth present (see Table 8.35). An individual was only scored as affected if at least two teeth displayed signs of DEH. Results were further broken down into age-categories and sexes.

8.5.9.i. Age-based comparison

		NK	Post-NK	Total
Sub-adults	**n/N**	0/14	50/138	**50/152**
	%	-**	36.2**	**32.9**
Young Adults	**n/N**	47/135	104/363	**151/498**
	%	34.8	28.7	**30.3**
Middle adults	**n/N**	4/39	44/151	**48/190**
	%	10.3**	29.1**	**25.3**
Old adults	**n/N**	1/4	9/42	**10/46**
	%	25.0	21.4	**21.7**
Adult indet	**n/N**	5/17	8/54	**13/71**
	%	29.4	14.8	**18.3**
Total	**n/N**	**57/209**	**215/748**	**272/957**
	%	**27.3**	**28.7**	**28.4**

Table 8.34 Dental enamel hypoplasias in permanent teeth (** significant at the 0.95% confidence level)

'Tooth based results (Table 8.34) show no major differences between the New Kingdom (27.3%) and post-New Kingdom periods (28.7%), when compared for the overall sample. However, some significant differences were evident when viewed for age-categories seperately. In sub-adults, no teeth were affected during the New Kingdom period compared to 36.2% in the post-New Kingdom period (χ^2=7.559, df=1, p=0.006). An increase of 18.8% in middle adults also proved to be significant (χ^2=5.674, df=1, p=0.017).

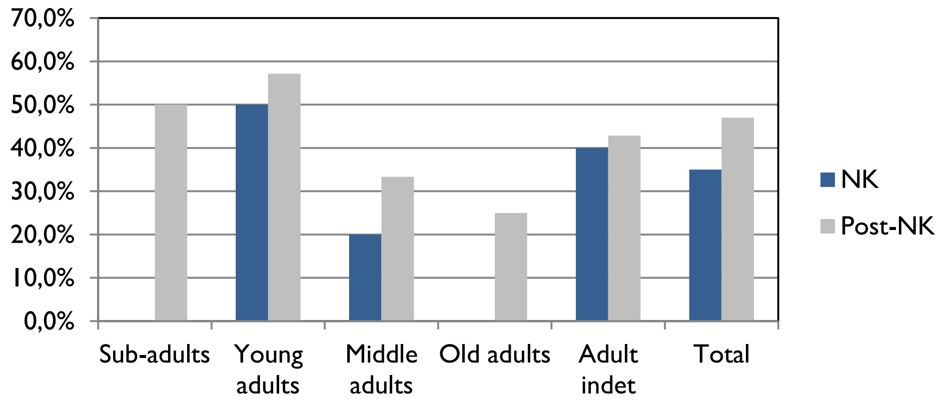

Figure 8.24 Comparison of individuals displaying dental enamel hypoplasias, by period

		NK	Post-NK	Total
Sub-adults	**n/N**	0/1	6/12	**13/19**
	%	-	50.0	**68.4**
Young Adults	**n/N**	4/8	16/28	**36/56**
	%	50.0	57.1	**64.3**
Middle adults	**n/N**	1/5	5/15	**20/26**
	%	20.0	33.3	**76.9**
Old adults	**n/N**	0/1	1/4	**5/6**
	%	-	25.0	**83.3**
Adult indet	**n/N**	2/5	3/7	**12/17**
	%	40.0	42.9	**70.6**
Total	**n/N**	**7/20**	**31/66**	**86/124**
	%	**35.0**	**47.0**	**69.4**

Table 8.35 Individuals displaying dental enamel hypoplasias

When diachronically comparing the number of individuals affected by DEH (see Figure 8.24, Table 8.35), there is a marked increase in the post-New Kingdom period for the overall sample, even though the difference was not statistically significant. The rise in sub-adults from 0.0% to 50.0% is likely an artefact of the small sample size in the New Kingdom (N=1). Rates generally decreased with increasing age, and the highest values were observed in young adults from both time periods (New Kingdom: 50.0%, post-New Kingdom: 57.1%).

8.5.9.ii. Differences between female and male individuals

Comparison of male and female individuals was only calculated for the number of individuals affected by DEH (see Table 8.36 and Figure 8.25). In both males and females, a statistically insignificant increase from the New Kingdom to the post-New Kingdom period (females +10.7%, males: +7.5%) was observed. In both time periods, rates were slightly higher in males than in females (New Kingdom: +4.2%, post-New Kingdom: +1%).

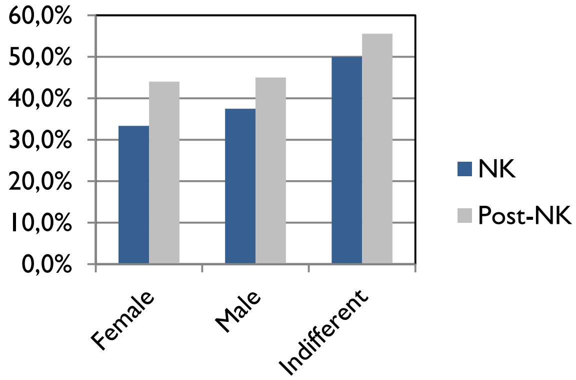

Figure 8.25 Comparison of DEH-prevalence between male and female individuals

		NK	Post-NK	Total
Female	**n/N**	3/9	11/25	14/34
	%	33.3%	44.0%	41.2%
Male	**n/N**	3/8	9/20	12/28
	%	37.5%	45.0%	42.9%
Indifferent	**n/N**	1/2	5/9	6/11
	%	50.0%	55.6%	54.5%
Total	**n/N**	**7/19**	**25/54**	32/73
	%	**36.8%**	**46.3%**	43.8%

Table 8.36 Female and male individuals affected by dental enamel hypoplasias

8.6. Deciduous teeth

8.6.1. Preservation

		NK	Post-NK
No dentition	**n**	0	151
	%	-	53.9
Tooth present	**n**	0	49
	%	-	17.5
Lost pm	**n**	0	57
	%	-	20.4
Lost am	**n**	0	0
	%	-	-
Broken pm	**n**	0	2
	%	-	0.7
Root only	**n**	0	0
	%	-	-
Congenitally absent	**n**	0	0
	%	-	-
Not erupted	**n**	0	10
	%	-	3.6
Isolated tooth	**n**	0	11
	%	-	3.9
Total positions observable		0	280

Table 8.37 Preservation of deciduous teeth

Preservation of deciduous teeth was generally very poor (see Table 8.37). The results for dental disease are presented as a percentage of possible tooth positions affected. Only 60 deciduous teeth (21.4% of possible), all of them from post-New Kingdom individuals, could be recovered. However, 53.9% of the dentitions were recorded as not preserved.

8.6.2. Dental pathologies in deciduous teeth

8.6.2.i. Caries in deciduous teeth

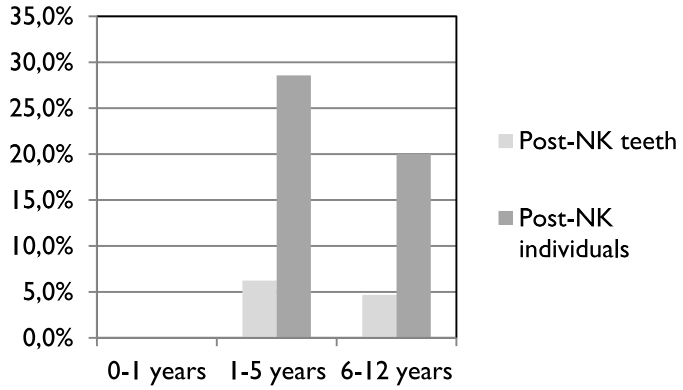

Figure 8.26 Caries in deciduous teeth by age category

		Per tooth		Per individual	
		NK	Post-NK	NK	Post-NK
1–5 years	n/N	0/0	4/20	0/0	2/7
	%	-	6.3	-	28.6
6–12 years	n/N	0/0	3/30	0/0	1/5
	%	-	4.7	-	20.0
Total	n/N	0/0	7/50	0/0	3/14
	%	-	14.0	-	21.4

Table 8.38. Caries prevalence in deciduous teeth

Caries in deciduous teeth was again calculated for the number of teeth preserved for observation as well as for the number of individuals with at least three deciduous teeth (see Figure 8.26 and Table 8.38). Due to the lack of sub-adults in the New Kingdom sample, this analysis only involved post-New Kingdom individuals. Caries was already affecting the deciduous dentition, with a total of 14.0% of all teeth (3 out of 14 individuals) showing carious lesions. Prevalence was slightly higher in young infants 5 years or less, with two individuals (28.6%) being affected in contrast to only one individual in older infants (20.0%). However, the sample size is very small.

8.6.2.ii. Dental enamel hypoplasias

Figure 8.27 and Table 8.39 how the evidence for DEH in the deciduous teeth which was generally rare. Results were calculated for the number of teeth affected and for the number of individuals with at least two teeth present. Only two teeth were affected in total (3.1% of the total sample). With regard to individuals affected, one individual in the 1–5 year group and one individual in the 6–12 years group each had one tooth with hypoplasia.

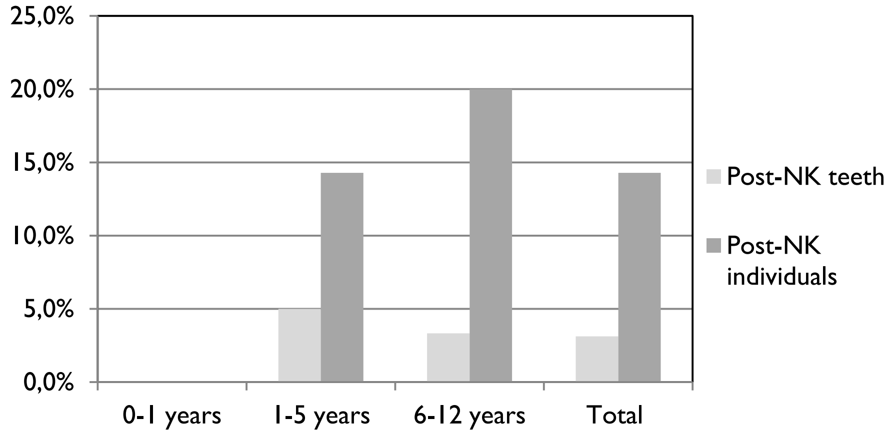

Figure 8.27 DEH in deciduous teeth

		Post-NK teeth	Post-NK individuals
0–1 years	n/N	0/14	0
	%	-	0.0%
1–5 years	n/N	1/20	1/7
	%	5.0%	14.3%
6–12 years	n/N	1/30	1/5
	%	3.3%	20.0%
Total	n/N	2/64	1/14
	%	3.1%	14.3%

Table 8.39 Sub-adult individuals with DEH in the deciduous teeth

8.7. Orbital lesions

		No lesion		Grade 1		Grade 2		Grade 3		Total	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Sub-adults	**n**	0	9	0	2	1	23	1	3	**2**	**37**
	%	-	24.3	-	5.4	50.0	62.2	50.0	8.1		
Young Adults	**n**	6	12	2	29	0	5	0	2	**8**	**48**
	%	75.0	25.0	25.0	60.4	-	10.4	-	4.2		
Middle adults	**n**	3	16	11	12	1	1	0	0	**15**	**29**
	%	20.0	55.2	73.3	41.4	6.7	3.4	-	-		
Old adults	**n**	0	8	0	2	0	0	0	0	**0**	**10**
	%	-	80.0	-	20.2	-	-	-	-		
Adult indet	**n**	1	4	5	2	0	3	0	0	**6**	**9**
	%	16.7	44.4	83.3	22.2	-	33.3	-	-		
Total	**n**	**10**	**49**	**18**	**47**	**2**	**32**	**1**	**5**	**31**	**133**
	%	**32.3**	**36.8**	**58.1**	**35.3**	**6.5**	**24.1**	**3.2**	**3.8**		

Table 8.40 Age-related frequencies of changes in the orbital roof (rates per number of orbitae preserved)

The results for the prevalence of changes in the orbital roof are presented based on the number of orbits preserved (see Table 8.40) and according to the number of individuals with at least one orbit present (see Figure 8.28 and Table 8.41). Results are further presented for different stages of expression (see Chapter 7). Changes were compared between time periods for the age-pooled sample as well as broken down into age categories. Changes in the orbital roof were generally very common in both samples (see Figure III.76–81), with only 32.3% of New Kingdom orbits and 36.2% of post-New Kingdom orbits were without changes. By for the most common type of changes were Grade 1 affecting 58.1% of New Kingdom but only 35.2% of post-New Kingdom orbitae. True porosity was generally rather rare. However, it represents the most common type of orbital lesion in sub-adult individuals. In post-New Kingdom individuals, grade 2-changes affected 62.2% of orbitae, and grade 3-changes 8.1% of all orbitae.

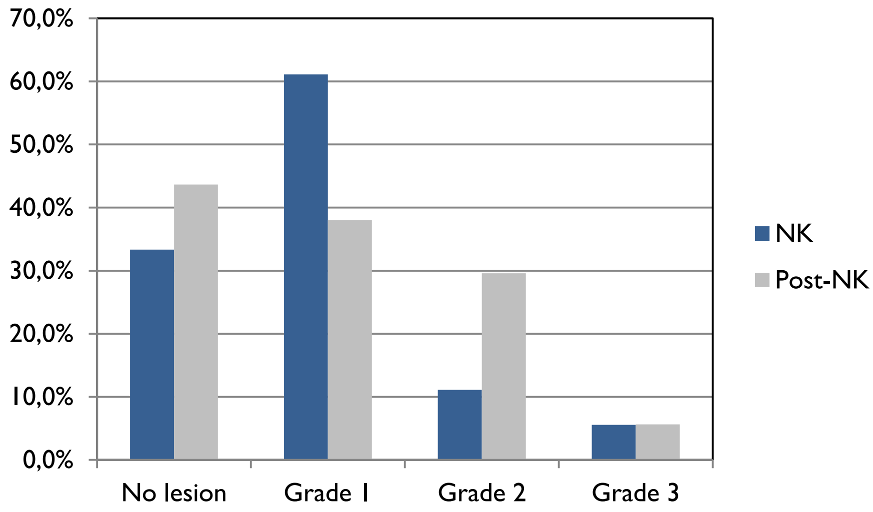

Figure 8.28 Distribution of orbital lesions

		No lesion		Grade 1		Grade 2		Grade 3		Total	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Sub-adults	n	0	7	0	1	1	14	1	2	1	19
	%	-	36.8	-	5.3	100.0	73.7	100.0	10.5		
Young Adults	n	3	9	1	17	0	4	0	2	4	26
	%	75.0	34.6	25.0	65.4	-	15.4	-	7.7		
Middle adults	n	2	9	7	7	1	1	0	0	9	15
	%	22.2	60.0	77.8	46.7	11.1	6.7	-	-		
Old adults	n	0	4	0	1	0	0	0	0	0	5
	%	-	80.0	-	20.0	-	-	-	-		
Adult indet	n	1	2	3	1	0	2	0	0	4	6
	%	25.0	33.3	75.0	16.7	-	33.3	-	-		
Total	n	**6**	**31**	**11**	**27**	**2**	**21**	**1**	**4**	18	71
	%	**33.3**	**43.7**	**61.1**	**38.0**	**11.1**	**29.6**	**5.6**	**5.6**		

Table 8.41 Age-related frequencies of changes in the orbital roof (rates per individual)

Rates were further calculated for the number of individuals with both orbitae present (see Figure 8.28 and Table 8.41). If changes were observed in an individual with only one orbit present, it was also included in the calculation. With regard to the number of individuals, only 33.3% of New Kingdom, but 43.7% of post-New Kingdom individuals, did not show any lesions. Again, vessel impressions were the most common type, with significant differences between the two time periods, decreasing from 61.1% during the New Kingdom to 38.0% during the post-New Kingdom period. In contrast, Grade 2 and 3 were more commonly observed in the post-New Kingdom, affecting 29.9% and 5.6% of the individuals respectively. With regard to age-related prevalence rates, the small sample size made valid comparison difficult. However, some trends could be observed. Grade 2-

lesions accounted for the majority of changes observed in sub-adults, while they were rarely observed in adult individuals. Significant diachronic differences were observed in young adult individuals. While in 75.0% of New Kingdom, changes in the orbital roof were entirely absent, this was only observed in 34.6% of post-New Kingdom individuals. However, the χ^2-test and Fisher's exact test did not reveal any statistical significance due to the small sample size. Vessel impressions were by far less common in the New Kingdom than in the post-New Kingdom but again this was not statistically significant. In middle adults, fewer New Kingdom individuals were without lesions (22.2%) than post-New Kingdom individuals (60.0%).

8.8. Infectious disease

8.8.1. New bone formation on the long bones (NBF)

8.8.1.i. General prevalence

Prevalence of bone formation on the long bones (see Figures III.89, III.90) was calculated according to the total number of each long bone and are presented for each segment of the bone separately in Table 8.42. Furthermore, frequencies were calculated according to the number of individuals displaying signs of new bone formation based on the number of individuals with at least one bone element present. In addition, the prevalence of bilateral new bone formation in individuals with both corresponding elements preserved was calculated (see Table 8.42).

		Part of bone shaft					
		p1/3		**m1/3**		**d1/3**	
Bone		**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Humerus	**n/N**	0/20	0/130	0/34	0/151	0/37	1/150
	%	-	-	-	-	-	0.7
Radius	**n/N**	0/36	0/137	0/33	0/141	0/32	0/131
	%	-	-	-	-	-	-
Ulna	**n/N**	1/37	0/164	0/36	0/145	0/33	0/135
	%	2.7	-	-	-	-	-
Femur	**n/N**	0/39	6/160	0/39	3/150	0/36	5/141
	%	-	3.8	-	2.0	-	3.5
Tibia	**n/N**	6/33	49/140	6/33	76/146	9/34	71/139
	%	18.2	35.0	18.2	52.1	26.5	51.1
Fibula	**n/N**	1/26	32/119	2/30	42/120	3/30	39/118
	%	3.8	26.9	6.7	35.0	10.0	33.1

Table 8.42 New bone formation based on the number of elements available in sections for each long bone (p=proximal, m= medial, d=distal)

Table 8.42 presents the frequencies of NBF based on the total number of bone elements observable according to each section of the shaft (proximal, medial and distal thirds of the diaphysis). The results were calculated for all individuals including sub-adults. This included only diaphyseal sections with a preservation score of 1 or 2 (>25%), except those sections which were less well preserved but did show signs of new bone formation. NBF in the upper extremity bones was generally very rare and only observed in one post-New Kingdom distal humerus (0.7%) and one New Kingdom proximal ulna (2.7%). Equally rare was new bone formation on the femur, which was only observed in individuals of the post-New Kingdom period. NBF on the femur occurred more commonly on the proximal (3.8%) than in the medial (2.0%) and distal portions (3.5%) of the shaft. By far the most common location for NBF were the tibiae and fibulae. Rates for all sections of the bones indicate a marked increase in NBF-prevalence during the post-New Kingdom period, ranging between 16.8% (proximal tibia) to 32.9% (medial tibia).

8.8.1.ii. Bilateral new bone formation on the tibiae and fibulae

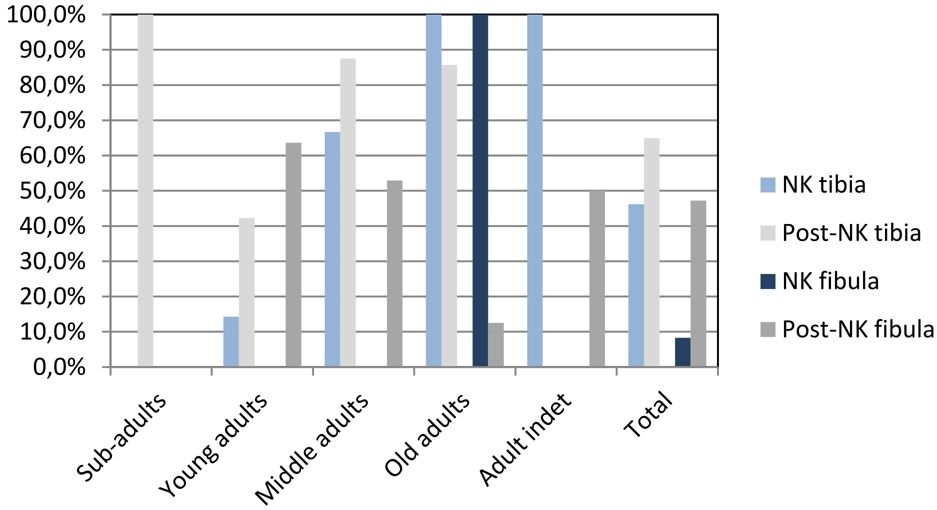

Figure 8.29 Comparison of bilateral new bone formation on tibiae and fibulae according to age-at-death

		Tibia		Fibula	
		NK	Post-NK	NK	Post-NK
Sub-adults	n/N	0/1	6/6	0/0	0/4
	%	-	100.0	.	.
Young Adults	n/N	1/7	11/26	0/7	14/22
	%	14.3	42.6	.	63.9
Middle adults	n/N	2/3	14/16	0/4	9/17
	%	66.7	87.5	.	52.9
Old adults	n/N	1/1	6/7	1/1	1/8
	%	100.0	87.5	100.0	12.5
Adult indet	n/N	1/1	0/2	0/0	1/2
	%	100.0	-	-	50.0
Total	n/N	6/13	37/57	1/12	25/53
	%	46.2	64.9	8.3	47.2

Table 8.43 Individuals with NBF and individuals with bilateral NBF on the tibiae and fibulae

When only considering individuals who displayed evidence of NBF in both tibiae or fibulae, the results (see Figure 8.29 and Table 8.43) again show a marked increase in the post-New Kingdom period, affecting 64.9% of individuals in contrast to only 46.2% during the post-New Kingdom period. However, this difference did not prove to be statistically significant according to a χ^2-test. With regard to the tibia, prevalence rises with increasing age at death in both time periods. However, the reverse trend was observed in the fibulae. In sub-adults bilateral NBF was only observed in the tibiae, affecting all of the individuals with both tibiae present.

8.8.1.iii. "Activity" of new bone formation (woven/active versus lamellar/healed bone)

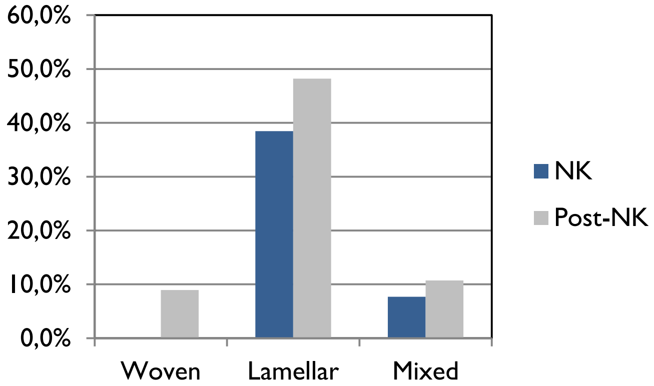

Figure 8.30 Activity levels of bilateral new bone formation in the tibiae

		NK	Post-NK	Total
Active	n	0	5	5
	%	-	8.9%	7.2%
Healed	n	5	27	32
	%	38.5%	48.2%	46.4%
Mixed	n	1	6	7
	%	7.7%	10.7%	10.1%

Table 8.44 Comparison of individuals affected by different stages of activity of bilateral new bone formation in the tibiae

In addition, all examples of bilateral new bone formation in the tibae were compared with regard to activity status at the time of death (see Figure 8.30 and Table 8.44). Active changes were generally rare, even though there was a slight increase in the post-New Kingdom period with five individuals (8.9%) affected. Mixed lesions (woven and lamellar bone) were equally uncommon, with 7.7% during the New Kingdom and 10.7% during the post-New Kingdom period. In 38.5% of New Kingdom individuals and 48.2% of post-New Kingdom individuals with both tibiae observable, the majority of lesions were healed at the time of death.

8.8.2. Maxillary sinusitis

8.8.2.i. Age-based comparison

		NK	Post-NK	Total
Sub-adults	n/N	0/2	1/13	1/15
	%	-	7.7	6.7
Young Adults	n/N	8/9	23/33	31/41
	%	88.9	69.7	73.8
Middle adults	n/N	11/13	11/17	22/30
	%	84.6	64.7	73.3
Old adults	n/N	1/2	8/10	9/12
	%	50.0	80.0	75.0
Adult indet	n/N	6/8	6/13	12/21
	%	75.0	46.2	57.1
Total	n/N	26/34	49/86	75/120
	%	**76.5****	**57.0****	62.5

Table 8.45 Age-related frequencies of new bone formation in the maxillary sinus (** statistical significance atthe 0.95% level): number of sinuses affected

Evidence of inflammation of the maxillary sinuses was based on new bone formation in the sinuses (see Figure III.91). Prevalence rates were calculated for the number of maxillary sinuses observable for new bone formation (see Table 8.45) as well as for the number of individuals with at least one maxillary sinus observable (see Table 8.46 and Figure 8.31). Results were further analysed for each age category separately. Evidence for sinus inflammation was generally common in both time periods even though the frequency was significantly higher during the New Kingdom period (χ^2=3.951, df=1, p=0.047). The same trend was also observed when broken down into age categories, showing that both in young and middle adult individuals, rates were higher during the New Kingdom. In both time periods, there were no major differences between the age categories. The highest rate was observed in New Kingdom young adults (88.6%). The lowest frequency was observed in New Kingdom old adults (50.0%) but this number is based on only one individual. In sub-adults, one individual (7.7%) from the post-New Kingdom period had already experienced chronic infection of the maxillary sinus, and in New Kingdom sub-adults no such evidence was detected.

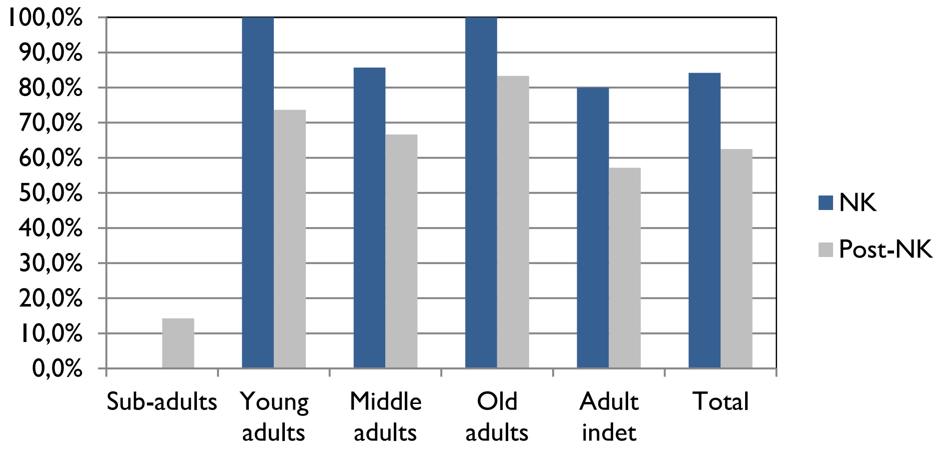

Figure 8.31 Individual-based prevalence of new bone formation in the maxillary sinus

		NK	Post-NK	Total
Sub-adults	**n/N**	0/1	1/7	**1/8**
	%	-	14.3	**12.5**
Young Adults	**n/N**	5/5	14/19	**19/24**
	%	100.0	73.7	**79.2**
Middle adults	**n/N**	6/7	6/9	**12/16**
	%	85.7*	66.7*	**75.0**
Old adults	**n/N**	1/1	5/6	**6/7**
	%	100.0	83.3	**85.7**
Adult indet	**n/N**	4/5	4/7	**8/12**
	%	80.0	57.1	**66.7**
Total	**n/N**	**16/19**	**30/48**	**46/67**
	%	**84.2**	**62.5**	**68.7**

Table 8.46 Individuals affected by maxillary sinusitis (*significant at the 90% confidence level)

When analysed at an individual level (see Figure 8.31 and Table 8.46), frequencies are generally high with 84.2% of New Kingdom individuals and only 62.5% of the post-New Kingdom individuals showing evidence of new bone formation in the maxillary sinuses. Only in middle adults, the frequency is markedly higher during the New Kingdom period. This difference did prove to be statistically significant at the 90% confidence level (χ^2=2.981, df=1, p=0.084).

8.8.2.ii. Comparison of female and male individuals

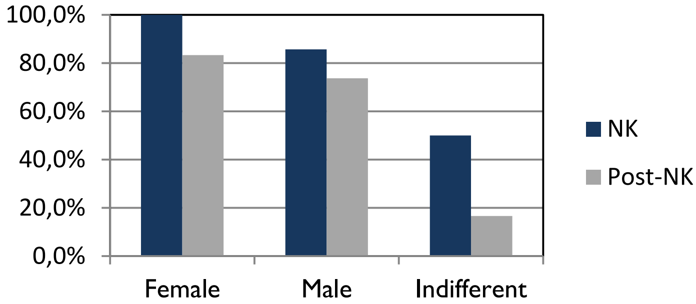

Figure 8.32 Comparison of female and male individuals affected by maxillary sinusitis

		Elements		Individuals	
		NK	**Post-NK**	**NK**	**Post-NK**
Female	**n/N**	15/16	24/31	9/9	15/18
	%	93.8	77.4	100.0	83.3
Male	**n/N**	10/12	23/33	6/7	14/19
	%	83.3	69.7	85.7	73.7
Indifferent	**n/N**	1/2	2/12	1/1	1/6
	%	50.0	16.7	50.0	16.7

Table 8.47 Sex-related comparison of individuals affected by pathological lesions in the maxillary sinus

Evidence of maxillary sinusitis was further compared between the sexes for both time periods (see Figure 8.32 and Table 8.47). Results based on the number of maxillary sinuses observable and based on the number of individuals affected are presented in Table 8.47. In both time periods, changes were generally more common in females than in males (Sinuses affected: New Kingdom: 93.8% vs. 83.3%; post-New Kingdom 77.4% vs. 69.7%; individuals affected: New Kingdom 100.0% vs. 85.7%, 85.7% vs. 73.7%). However, none of these differences was statistically significant.

8.8.2.i. „Activity“ of new bone formation in the maxillary sinuses

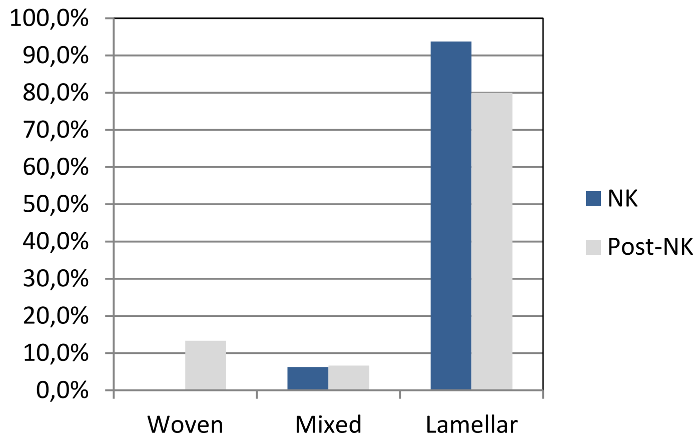

Figure 8.33 "Activity" levels of NBF in the maxillary sinuses (based on the number of individuals affected/ observable)

		NK	Post-NK	Total
Woven	n	0	4	4
	%	-	13.3%	8.7%
Mixed	n	1	2	3
	%	6.3%	6.7%	6.5%
Lamellar	n	15	24	39
	%	93.8%	80.0%	84.8%

Table 8.48 Comparison of individuals affected by different stages of "activity" of NBF in the maxillary sinuses

In addition, all individuals with NBF in the maxillary sinuses were compared with regard to activity status at the time of death (see Figure 8.33 and Table 8.48). Active changes were generally rare, even though there is a slight increase in the post-New Kingdom period with four individuals (13.3%) affected. Mixed lesions (woven and lamellar bone) were equally uncommon, in both time periods. The vast majority of individuals however (93.8% of the New Kingdom individuals, 80.0% of post-New Kingdom individulas displayed lamellar NBF. The differences did not prove to be statistically significant.

8.8.3. New bone formation on the ribs

8.8.3.i. Age-based comparison

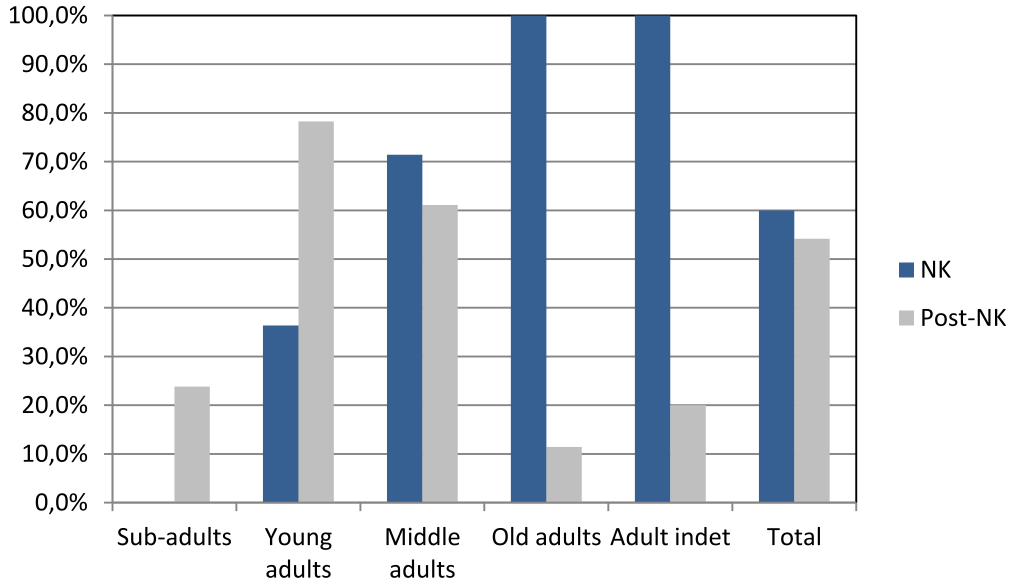

Figure 8.34 Comparison of age-related prevalence of new bone formation in the ribs according to individuals affected

		NK	Post-NK	Total
Sub-adults	**n/N**	0/1	5/21	5/22
	%	-	23.8	22.7
Young Adults	**n/N**	4/11	18/23	22/34
	%	36.4**	78.3**	64.7
Middle adults	**n/N**	5/7	11/18	16/25
	%	71.4	61.1	64.0
Old adults	**n/N**	1/1	4/35	5/36
	%	100.0	11.4	13.9
Adult indet	**n/N**	5/5	1/5	6/10
	%	100.0	20.0	60.0
Total	**n/N**	**15/25**	**39/72**	**54/97**
	%	**60.0**	**54.2**	**55.7**

Table 8.49 New bone formation in the ribs – individuals affected (** significant at the 0.95% confidence level)

Prevalence of NBF on the ribs (lower respiratory tract) was calculated based on the occurrence of new bone formation on the visceral side of the ribs (see Figurea III.92, III.3) and calculated for the number of individuals with at least six ribs present. Only sub-adults older than 5 years at death were included in the analyses. Results were compared between time periods for the entire sample and broken down into age categories (see Figure 8.34 and Table 8.49). New bone formation was generally very common throughout the sample.

When comparing overall results, periosteal reaction on the ribs was more commonly observed in the New Kingdom (60.0%) than in the post New Kingdom samples (54.2%). However, the difference was not statistically significant. Significant differences between the time periods were only observed in the young adult age range (χ^2=4.823, df=1, p=0.028, Fisher's Exact Test: p=0.035). Pathological changes affected 78.3% of the New Kingdom young adults in contrast to 36.4% of the New Kingdom young adults. The large difference between old adult individuals (New Kingdom: 100.0%, post-New Kingdom: 11.4%) is not to be regarded as representative given N=1 individual during the New Kingdom period. Within the sub-adult group 22.7% of all sub-adult individuals (post-New Kingdom only 23.8%) were already affected by a chronic disease in the lungs.

8.8.3.ii. Comparison of male and female individuals

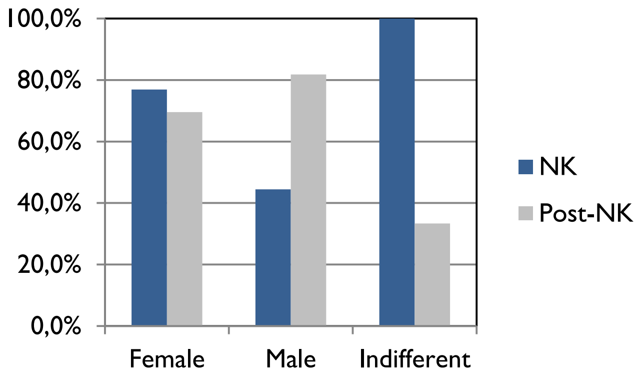

Figure 8.35 Sex-based comparison of individuals affected with ribs preserved

		NK	Post-NK	Total
Females	**n/N**	10/13	16/23	26/36
	%	76.9	69.6	72.2
Males	**n/N**	4/9	18/22	22/31
	%	44.4**	81.8**	71.0
Indifferent	**n/N**	1/1	2/6	3/7
	%	100.0	33.3	42.9
Total adults	n/N	15/23	36/51	51//74
	%	65.2*	70.6*	68.9

Table 8.50 Diachronic comparison of the prevalence of NBF on ribs between male and female individuals (based on the number of individuals with ribs observable)

The prevalence of new bone formation on the ribs was further compared between females and males for both time periods (see Figure 8.35 and Table 8.50). As for the overall sample, there was only a small difference between men and women, even though it was slightly more common in female than in male individuals (females: 72.2%, males:

71.0%). When compared for the overall adult samples, again the prevalence was slightly higher in the post-New Kingdom than in the New Kingdom population. However, some differences were observed both between the sexes and within each sex group. In the New Kingdom period, the prevalence was significantly higher in females (76.6%) than in males (44.4%). During the post-New Kingdom period, the opposite held true, with 81.8% of all males but only 69.6% of the females being affected. Within the female sub-sample, there was a slight decrease from 76.9% to 69.6% in the later period. In contrast, a sharp increase was observed during the post-New Kingdom period. This difference proved to be statistically significant using a χ^2-test (χ^2=4.330, df=1, p=0.037) even though the Fisher's exact test, carried out due to the small number of individuals in the New Kingdom sample, revealed statistical significance only in the 90% confidence range (p=0.077).

8.8.3.iii. "Activity" of NBF

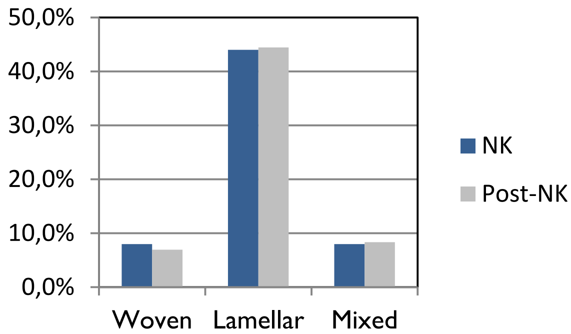

Figure 8.36 "Activity" of rib lesions (% of individuals affected)

		NK	Post-NK	Total
Active	n/N	2/25	5/72	**7/97**
	%	8.0	6.9	**7.2**
Healed	n/N	11/25	32/72	**43/97**
	%	44.0	44.4	**44.3**
Mixed	n/N	2/25	6/72	**8/97**
	%	8.0	8.3	**8.2**

Table 8.51 "Activity" of rib lesions (% of individuals affected)

Rib lesions were further analysed with regard to their "activity" status (see Figure 8.36 and Table 8.51). Active lesions were only detected in a small number of individuals with no major differences between New Kingdom (8.0%) and post-New Kingdom (6.8%) individuals. The majority of individuals affected by rib lesions displayed healed new bone formation (New Kingdom: 44.0%, post-New Kingdom: 44.4%). Mixed lesions were equally rare, affecting 8.0% of New Kingdom individuals with observable ribs and 8.3% of post-New Kingdom individuals.

8.8.4. Changes on the endocranial side of the skull

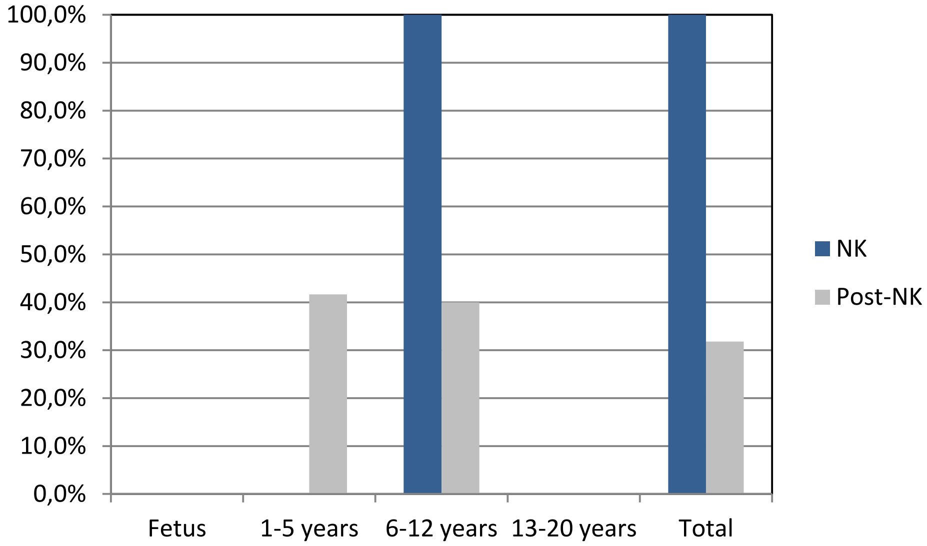

Figure 8.37 Endocranial changes amongst sub-adult individuals by age group

		NK	Post-NK	Total
Neonates	**n/N**	0/0	0/2	0/2
	%	-	-	-
1–5 years	**n/N**	0/0	7/12	7/12
	%	-	58.3	58.3
6–12 years	**n/N**	1/1	2/5	3/6
	%	100	40.0	50.0
13–20 years	**n/N**	0/0	0/3	0/3
	%	-	-	0.0
Total	**n/N**	**1/1**	**9/22**	**10/23**
	%	**-**	**40.9**	**43.5**

Table 8.52 Rates of endocranial changes in sub-adult individuals by age group

Rates for bone changes on the endocranial surface of the skull (see Figures III.94–98) were calculated based on the number of individuals with at least 50% of the skull vault preserved. Results were calculated seperately for sub-adult (see Figure 8.37 and Table 8.52) and adult individuals (see Figure 8.38 and Table 8.53). Diachronic comparison between sub-adults again was hindered by the low number of New Kingdom individuals. In the post-New Kingdom period, endocranial changes represented a frequent finding, affecting

40.9% of individuals. They most commonly occurred in the 1–5 year (58.3%) and 6–12 year age ranges (40.0%) while no changes were observed in the 13–20 year range.

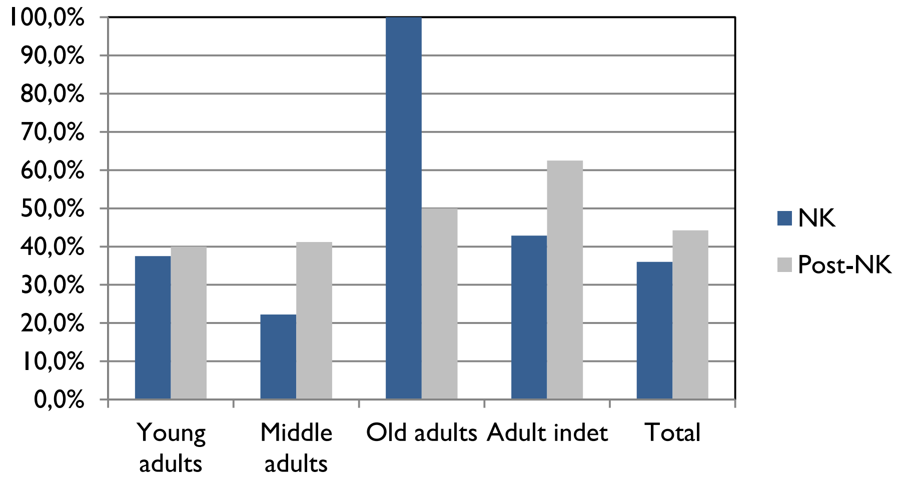

Figure 8.38 Endocranial lesions in adult individuals with cranial vaults preserved

		NK	Post-NK	Total
Young adults	**n/N**	3/8	12/30	15/38
	%	37.5	40.0	39.5
Middle adults	**n/N**	2/9	7/17	9/26
	%	22.2	41.2	34.6
Old adults	**n/N**	1/1	3/6	4/7
	%	100.0	50.0	57.1
Adult indet	**n/N**	3/7	5/8	8/15
	%	42.9	62.5	53.3
Total	**n/N**	**9/25**	**27/61**	36/86
	%	**36.0**	**44.3**	41.9

Table 8.53 Prevalence of endocranial changes in adult individuals with cranial vaults preserved

In adult individuals (see Figure 8.38 and Table 8.53), rates of endocranial lesions increased slightly from the New Kingdom to the post-New Kingdom period. This trend is visible in the combined samples (New Kingdom: 36.0%, post-New Kingdom: 44.5%) as well as broken down into age categories. The sharpest increase is observable in middle adult individuals, rising from 22.2% in the New Kingdom period to 41.2% in the post-New Kingdom period, even though a χ^2-test did not reveal any statistical significance of this difference.

8.9. Diseases of the joints

8.9.1. Osteoarthritis of extra-spinal joints

Even though each joint surface was examined seperately for evidence of osteoarthritis, the results are presented for combined joint complexes. For an overview of composition of joint complexes, see Chapter 7. Prevalence rates for each complex were calculated for the number of individuals with at least one joint surface preserved (see Figure 8.39 and Table 8.54). Osteoarthritis was scored as present if at least one joint surface in a joint showed signs of marginal osteophytes together with porosity and/or eburnation (see Figures III.99–101). Prevalence rates were further analysed for young adult and middle adult individuals separately (see Figure 8.40), and compared in each age category and for each joint complex seperately.

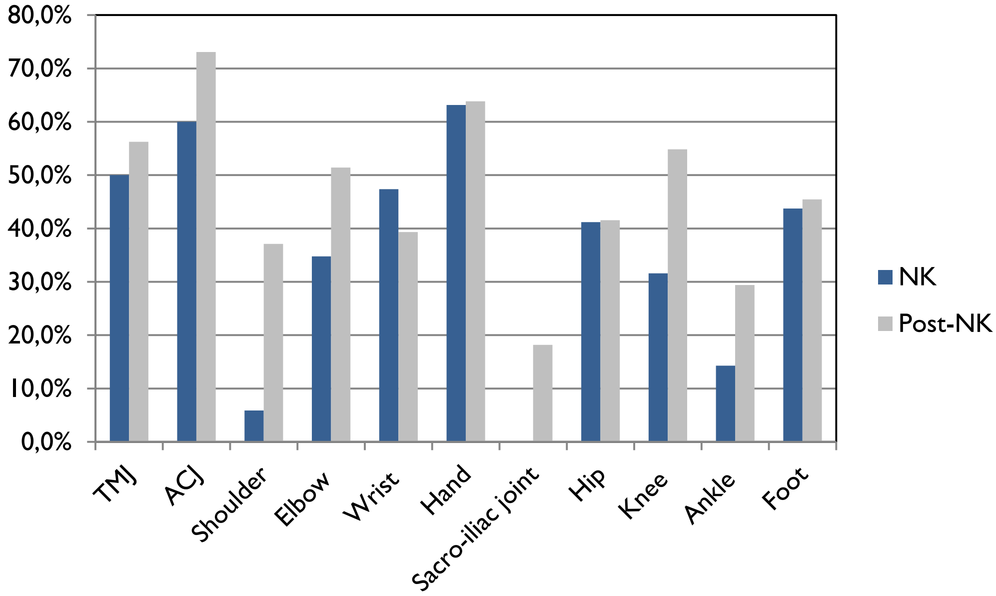

Figure 8.39 Comparison of osteoarthritis prevalence

Joint		NK	Post-NK	Total	Joint	NK	Post-NK	Total
TMJ	**n/N**	4/8	18/32	22/36	**Sacro-iliac joint**	0/2	2/11	2/13
	%	50.0	56.3	55.0		-	18.2	15.4
ACJ	**n/N**	6/10	38/52	44/62	**Hip**	7/17	27/65	34/82
	%	60.0	73.1	71.0		41.2	41.5	41.5
Gleno-humeral	**n/N**	**1/17**	**23/62**	24/79	**Knee**	6/19	34/62	40/81
	%	**5.9****	**37.1****	30.4		31.6	54.8	49.4
Elbow	**n/N**	8/23	36/70	44/103	**Ankle**	2/14	15/51	17/65
	%	34.8	51.4	47.3		14.3	29.4	26.2
Wrist	**n/N**	9/19	24/61	33/80	**Foot**	7/16	25/55	32/71
	%	47.4	39.3	41.3		43.8	45.5	45.1
Hand	**n/N**	12/19	30/47	42/66				
	%	63.2	63.8	63.6				

Table 8.54 Prevalence of osteoarthritis in all major joint complexes (** statistically significant at the 0.95% confidence level: values all age categories pooled)

Evidence for osteoarthritis was generally high in all joints (see Table 8.54), according to joint complexes affected. When pooled for the entire sample, the highest frequencies were obtained for the acromio-clavicular joint (ACJ, 71.0%), and the joints of the metacarpals and phalanges (63.3%) and temporomandibular joints (TMJ, 55.0%). osteoarthritis of the sacro-iliac and ankle joints were least commonly observed (see Table 8.54). With the exception of the wrist joints, frequencies were generally higher in the post-New Kingdom period. Major differences were observed in the shoulder, sacro-iliac, knee and ankle joints, even though only differences in the shoulder joint proved to be statistically significant when using a χ^2-test (χ^2=6.146, df=1, p=0.013).

		Young adults			Middle adults		
Joint		NK	Post-NK	Total	NK	Post-NK	Total
TMJ	n/N	1/1	5/15	**6/16**	2/4	7/8	**9/12**
	%	100.0	33.3	**37.5**	50.0	87.5	**75.0**
ACJ	n/N	2/5	16/23	**18/28**	3/3	12/16	**15/19**
	%	40.0	69.6	**64.3**	100.0	75.5	**78.9**
Shoulder	n/N	0/7	7/26	**7/33**	1/6	11/19	**12/25**
	%	-	26.9	**21.2**	16.7	57.9	**48.0**
Elbow	n/N	1/9	12/31	**13/40**	2/7	14/21	**16/28**
	%	11.1	38.7	**32.5**	28.6	66.9	**57.1**
Wrist	n/N	2/9	7/26	**9/35**	3/5	9/18	**12/23**
	%	22.2	26.9	**25.7**	60.0	50.0	**52.2**
Hand	n/N	3/6	8/19	**11/25**	5/8	16/16	**21/24**
	%	50.0	42.1	**44.0**	62.5**	100.0**	**87.5**
Sacro-iliac joint	n/N	0/1	1/5	**1/6**	0/1	1/3	**1/4**
	%	-	20.0	**16.7**	-	33.3	**25.0**
Hip	n/N	2/7	13/30	**15/37**	4/6	9/31	**13/27**
	%	28.6	43.3	**40.5**	66.7	42.9	**48.1**
Knee	n/N	0/9	13/27	**13/36**	2/6	15/21	**17/27**
	%	-	48.1**	**36.1**	33.3	71.4	**63.0**
Ankle	n/N	0/6	3/23	**3/29**	1/6	9/20	**10/26**
	%	-	13.0	**10.3**	16.7	45.0	**38.5**
Foot	n/N	2/7	8/24	**10/31**	4/6	13/17	**17/23**
	%	28.6	33.3	**32.3**	66.7	76.5	**73.9**

Table 8.55 Prevalence of osteoarthritis amongst young and middle adult individuals (** statistically significant at the 0.95% confidence level)

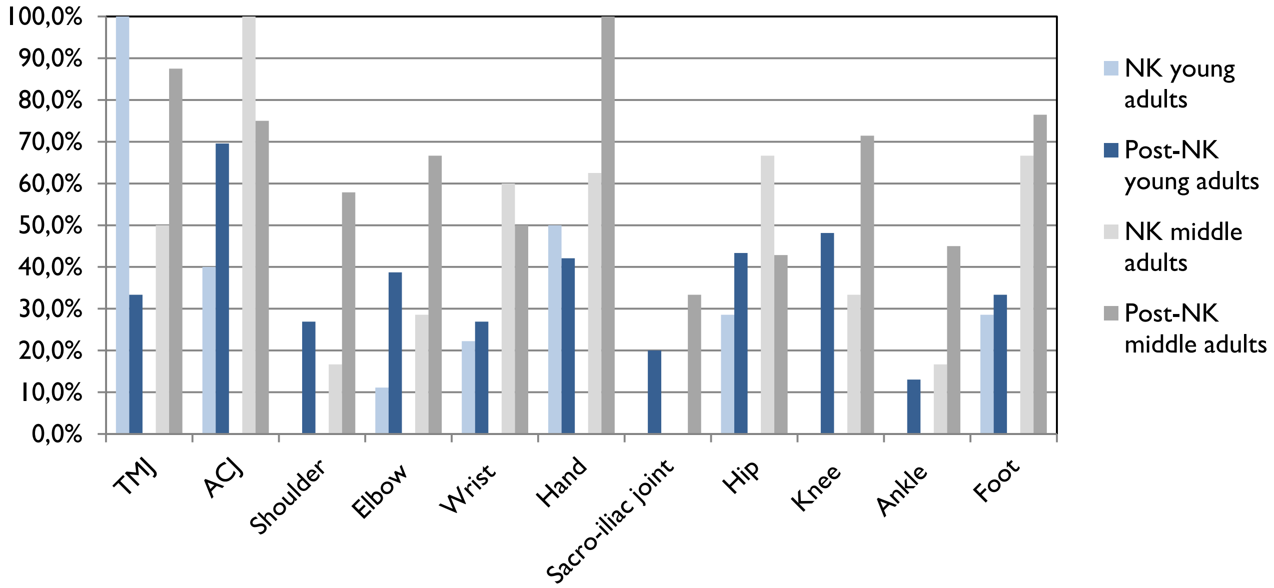

Figure 8.40 Diachronic comparison of osteoarthritis in young and middle adult individuals

When analysing the young adult age group, (see Figure 8.40 and Table 8.55) the prevalence of osteoarthritis was already notably high, particularly in the post-New Kingdom sample. The most commonly affected joints were the ACJ (New Kingdom: 40.0%, post-New Kingdom: 69.6%) during the post-NK sample, hands (New Kingdom: 50.0%, post-New Kingdom: 42.1%), hips (New Kingdom: 28.6%, post-New Kingdom: 43.3%) and knees (New Kingdom: 0.0%, post-New Kingdom: 48.1%). With the exception of the joints of the hands, frequencies were higher in the post-New Kingdom period. The higher value for the New Kingdom sample observed in the TMJ is excluded since the New Kingdom sample only comprises a single individual. Major differences were observed for ACJ (+29.6%), shoulder (+26.9%) and elbow joints (+26.6%) as well as the sacro-iliac (+20.0%), hip (+14.6%), knee (+48.1%) and ankle joints (+13.0%), even though these large discrepancies may partly be explained by the small sample size in the New Kingdom sample. A statistically significant increase in the later stage of use of the cemeteries could only be observed in the knee joint ($\chi^2=6.783$, df=1, $p=0.009$, Fisher's exact $p=0.009$ (1-sided significance)). In contrast, in the wrist, hand and feet joints, the prevalence of osteoarthritis only changed by a small margin (wrist: +4.7%, hand: -7.9% and feet +4.7%).

Temporal trends in the middle adult individuals were generally very similar to the young adults and the overall sample, showing a significant increase in osteoarthritis for most major joint complexes during the post-New Kingdom period. Values were particularly high for the TMJ (87.5%) as well as the large joints of the upper extremity in post-New Kingdom individuals (ACJ: 75.5%; elbow: 66.9% and shoulder: 57.9%).

8.9.2. Rotator cuff disease (RCD)

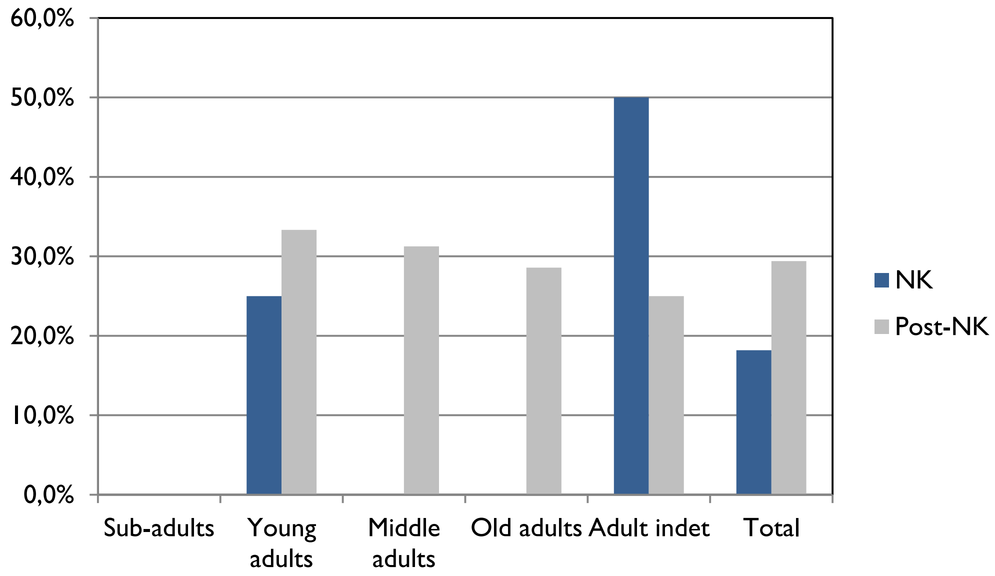

Figure 8.41 Comparison of individuals with evidence of RCD

		NK	Post-NK	Total
Sub-adults	**n/N**	0/0	0/3	**0/3**
	%	-	-	**-**
Young Adults	**n/N**	1/4	7/21	**8/25**
	%	25.0	33.3	**32.0**
Middle adults	**n/N**	0/5	5/16	**5/21**
	%	-	31.3	**23.8**
Old adults	**n/N**	0/0	2/7	**2/7**
	%	-	28.6	**28.6**
Adult indet	**n/N**	1/2	1/4	**2/6**
	%	50.0	25.0	**33.3**
Total	**n/N**	**2/11**	**15/51**	**17/62**
	%	**18.2**	**29.4**	**27.4**

Table 8.56 Individuals with evidence for rotator cuff disease

The prevalence of RCD (see Figure III.102) was calculated based on the number of individuals with at least one humeral head and proximal shaft preserved. The results are presented in Figure 8.41 and Table 8.56. Overall there is a marked increase from the New Kingdom (18.2%) to the post-New Kingdom period (29.4%). A χ^2-Test did not reveal any statistical significance. The trend towards higher levels of RCD in the post-New Kingdom period was observed in all age categories. Frequencies were highest in young adults (New Kingdom: 25% and post-New Kingdom 33.3%).

8.9.3. Osteoarthritis in the synovial joints of the spine

8.9.3.i. Age-related comparison

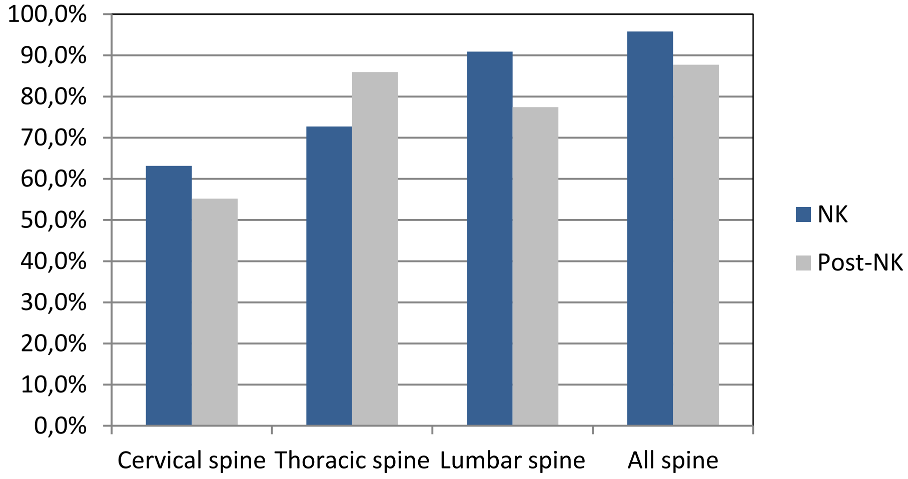

Figure 8.42 Prevalence of osteoarthritis in the synovial joints of the cervical, thoracic and lumbar spine (all age groups pooled)

		All spine		Cervical		Thoracic		Lumbar	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Young adults	n/N	8/9	27/32	5/7	9/28	6/8	25/29	8/9	18/30
	%	88.9	84.4	71.4*	32.1*	75.0	86.2	88.9	60.0
Middle adults	n/N	8/8	23/23	3/6	17/18	6/8	5/7	7/7	21/22
	%	100.0	100.0	50.0**	94.4**	75.0	71.4	100.0	95.5
Old adults	n/N	1/1	8/8	1/1	5/7	0/1	5/7	1/1	5/6
	%	100.0	100.0	100.0	71.4	0.0	71.4	100.0	83.3
Indifferent	n/N	6/6	6/10	3/5	1/5	4/5	4/7	4/5	4/4
	%	100.0	60.0	60.0	20.0	80.0	57.1	80.0	100.0
Total	n/N	23/24	64/73	12/19	32/58	16/22	55/64	20/22	48/62
	%	95.8	87.7	63.2	55.2	72.7	85.9	90.9	77.4

Table 8.57 Age-related prevalence of osteoarthritis in the synovial joints of the spine (** statistically significant at the 0.95% confidence level, * at the 0.90% level)

The results for spinal osteoarthritis are presented for the overall spine and sections of the spine, for all adult age ranges pooled, as well as seperately for each age group (see Figure 8.42, Table 8.57 and Figure 8.43). Percentages were calculated based on the number of individuals with vertebrae present for each spinal section. The prevalence of osteoarthritis in the intervertebral joints was generally very high for all sections of the spine. When analysed for the entire spine combined, results were relatively similar for both time periods. A slight difference was detected in the pooled age sample, with 95.8% of all

New Kingdom individuals but only 87.7% of post-New Kingdom individuals displaying changes caused by osteoarthritis. However, major differences were visible in each section of the spine. In the cervical spine, a decrease of 39.7% from the New Kingdom to the post-New Kingdom period was observed. A χ^2-test revealed statistical significance at the 10% level of confidence (χ^2=3.601, df=1, p=0.058, Fisher's p=0.090) even though the small sample size may have influence this result. A similarly large and highly statistically significant difference (χ^2=6.400, df=1, p=0.011, Fishers p=0.035) was observed in the cervical spine of middle adult individuals even though the trend is reversed for young adult individuals, which again may be an artefact of the small sample size in the New Kingdom period.

Differences in the thoracic spine were less marked. Generally, there was a slight increase in osteoarthritis during the post-New Kingdom period, rising from 72.7% during the New Kingdom period to 85.9%. When analysing age groups seperately, this trend was mainly visible in young adults (New Kingdom 75.0%; post-New Kingdom: 86.2%). In middle adults the results wereagain similar. Comparison of old adults is limited due to the small sample size in the New Kingdom (N=1). None of these differences proved to be statistically significant.

In the lumbar spine, prevalence again was slightly higher in the New Kingdom than in the post-New Kingdom period at 90.9% against 77.4%. A major diachronic difference was only detected in young adults at 88.9% during the New Kingdom and 60.0% during the post-New Kingdom period, even though this difference was slightly outside of the range for statistical significance at the 10% confidence level (χ^2=2.600, df=1, p=0.107).

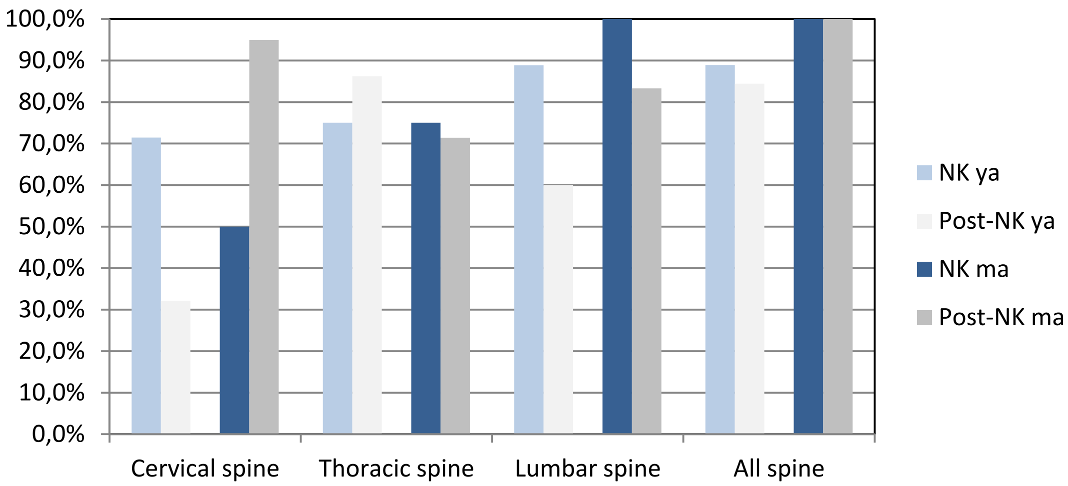

Figure 8.43 Comparison of osteoarthritis in the spinal joints in young (ya) and middle adult (ma) individuals

8.9.3.ii. Differences in male and female individuals

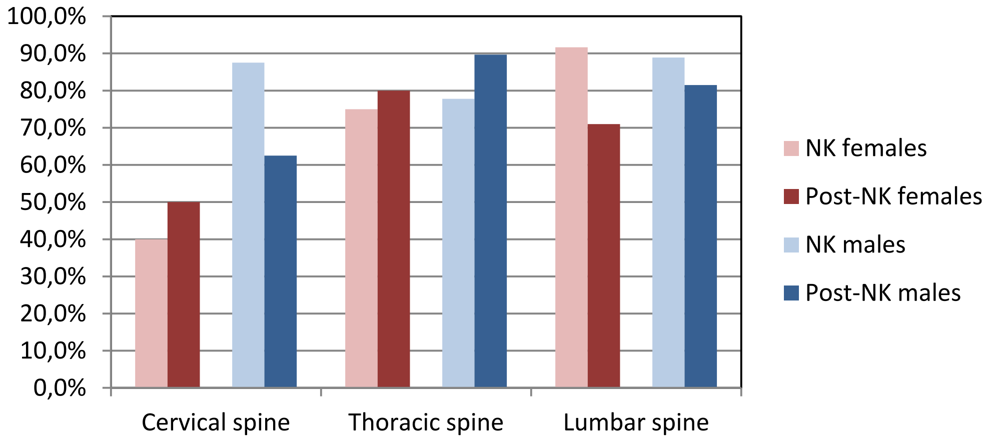

Figure 8.44 Differences in spinal osteoarthritis in male and female individuals

		All spine		Cervical		Thoracic		Lumbar	
		NK	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Females	**n/N**	13/14	31/71	4/10	14/28	9/12	24/30	11/12	22/31
	%	92.9	43.7	40.0	50.0	75.0	80.0	91.7	71.0
Males	**n/N**	9/9	27/32	7/8	15/24	7/9	26/29	8/9	22/27
	%	100.0	84.4	87.5	62.5	77.8	89.7	88.9	81.5
Indet.	**n/N**	1/1	8/23	1/1	3/6	0/1	9/10	1/1	7/9
	%	100.0	34.8	100.0	50.0	0.0	90.0	100.0	77.8
Total	**n/N**	23/24	66/126	12/19	32/58	16/22	59/69	20/22	51/67
	%	95.8	52.4	63.2	55.2	72.7	85.5	90.9	76.1

Table 8.58 Diachronic comparison of spinal osteoarthritis for male and female individuals

Figure 8.44 and Table 8.58 present the results comparing differences between male and female individuals. When compared for the overall spine, in female individuals prevalence was significantly lower in post-New Kingdom than in New Kingdom females (χ^2=11.335, df=1, p=0.001). Within segments this difference is particularly evident in the lumbar spine, with 91.7% of New Kingdom females affected but only 71.0% of post-New Kingdom females. In male individuals, prevalence was also higher in the New Kingdom than in the post-New Kingdom period, even though the difference was less pronounced. In males, the difference was most noticeable in the cervical spine, with a decrease of 25.0% in the post-New Kingdom period. However, this difference was not statistically significant.

8.9.4. Intervertebral disc disease (IVD)

8.9.4.i. Age-related comparison

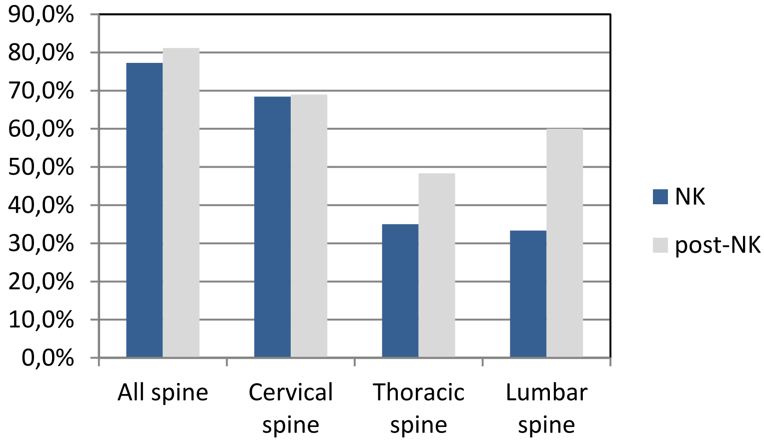

Figure 8.45 Diachronic comparison of IVD in the cervical, thoracic and lumbar spine

		All spine		Cervical		Thoracic		Lumbar	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Young adults	**n/N**	7/8	23/31	6/8	16/29	3/8	9/29	2/7	14/30
	%	87.5	74.2	75.0	55.2	37.5	31.0	28.6	46.7
Middle adults	**n/N**	7/8	21/23	4/5	14/16	1/5	12/19	2/5	14/21
	%	87.5	91.3	80.0	87.5	20.0*	63.2*	40.0	66.7
Old adults	**n/N**	1/1	7/8	0/1	6/7	1/1	5/7	1/1	5/6
	%	100.0	87.5	-	85.7	100.0	71.4	100.0	83.3
Indifferent	**n/N**	3/5	5/7	3/5	4/6	2/5	2/5	1/5	3/3
	%	60.0	71.4	60.0	66.7	40.0	40.0	20.0	100.0
Total	**n/N**	17/22	56/69	14/19	40/58	7/20	29/60	6/18	36/60
	%	77.3	81.2	73.7	69.0	35.0	48.3	33.3**	60.0**

Table 8.59 Prevalence of IVD in the overall spine and according to section of the spine (** statistical significance at the 0.95% confidence level)

Figure 8.45 and Table 8.59 presents the results of the analysis of intervertebral disc disease (IVD, see Figures III.103, III.104) compared for the overall spine as well as for cervical, thoracic and lumbar vertebrae seperately. Results were calculated based on the number of individuals with the relevant section of the spine preserved. Only adult individuals were included in this analysis. When compared for the pooled age groups (see Figure 8.45), no significant difference was obtained for the overall spine. When analysed for each section seperately, while values were high in both groups in the cervical spine, they differ considerably in the lower sections, with an increase of 13.3% in the thoracic and 26.7% in the lumbar vertebrae during the post-New Kingdom period. The latter proved to be highly statistically significant (χ^2=3.962, df=1, p=0.047)

In young adults, the prevalence of IVD was already very high with 87.5% of New Kingdom and 74.2% of post-New Kingdom individuals affected. However, when separated into sections of the spine, the table shows that these values are mainly due to high frequencies in the cervical spine whereas the thoracic and lumbar vertebrae are much less affected. Values were markedly higher in the neck vertebrae of New Kingdom individuals (75.0% vs. 55.2% in post-New Kingdom individuals), whereas the opposite is true for the lumbar vertebrae with an increase of 18.1% during the post-New Kingdom period.

In middle adult individuals, values for the cervical spine were again higher than in the other spinal sections with 80.0% affected during the New Kingdom and 87.5% in the post-New Kingdom period. It is further notable that the frequencies are now higher in the post-New Kingdom period in all sections of the spine (cervical spine: +7.5%, thoracic: +43.2%, lumbar: +26.7%), even though the small number of individuals in the New Kingdom period slightly limits the representative nature of the data. A χ^2-test revealed statistical significance at the 10% level of confidence ($\chi^2=3.468$, df=1, p=0.067).

The small sample size in the New Kingdom period is even more problematic in the old adult range, being only represented by one individual, and thus not allowing for any valid comparison. As for the post-New Kingdom period, the prevalence of IVD was high in all sections of the spine, with 85.7% of all individuals being affected. Highest values were again observed in the cervical spine (87.5%), even though in old adults prevalence in the lumbar spine was almost equal at 83.3%.

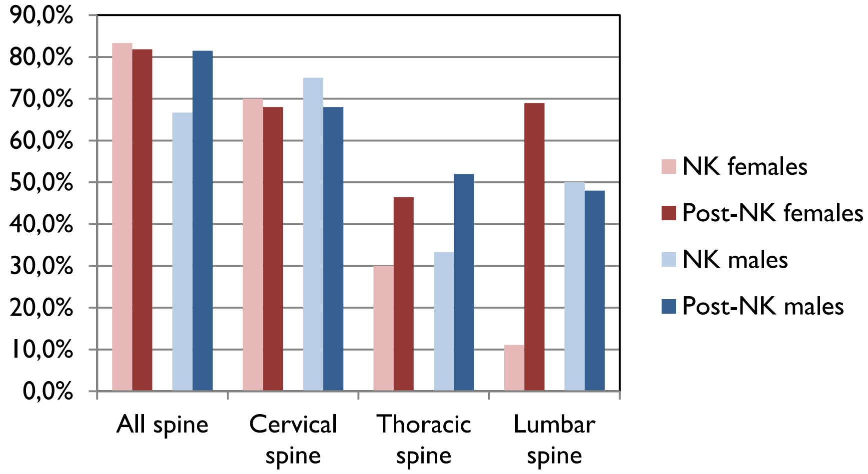

Figure 8.46 Comparison of the prevalence of IVD in the spine in male and female individuals

8.9.4.ii. Diachronic comparison of IVD between female and male individuals

		All spine		Cervical		Thoracic		Lumbar	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Females	n/N	10/12	27/33	7/10	17/25	3/10	13/28	1/9	20/29
	%	83.3	81.8	70.0	68.0	30.0	46.4	11.1**/*	69.0**
Males	n/N	6/9	22/27	6/8	17/25	3/9	13/25	4/8	12/25
	%	66.7	81.5	75.0	68.0	33.3	52.0	50.0*	48.0
Total	n/N	16/21	49/60	13/18	34/50	6/19	26/53	5/17	32/54
	%	76.2	81.7	72.2	68.0	31.6	49.1	29.4	59.3

Table 8.60 Sex-related prevalence of IVD (all age groups pooled)

IVD rates were further compared between the sexes for both time periods and pooled for all age ranges within each period (see Figure 8.46 and Table 8.60). The analysis only showed a few sex-related differences. When compared by sex within each group, the overall spine frequency rates were similar in post-New Kingdom males and female, whereas New Kingdom females were affected more commonly than males (females: 88.3%, males: 66.7%). When viewed for separate sections of the spine, results only differed between the sexes in the lumbar spine where rates were significantly higher in New Kingdom males and slightly higher in post-New Kingdom females. Comparing the results diachronically for each sex, while in females rates were similar for all vertebrae pooled, in males an increase of 14.8% during the post-New Kingdom period was observed. In the cervical spine results are similarly high in males and females for both time periods except for a slight decrease of 7% in post-New Kingdom males. In the thoracic and lumbar spine differences were again more marked. In the thoracic spine rates in both males and females rose considerably from 30.0% to 46.4% in females and 33.3% to 52.0% in males. In the lumbar vertebrae of female individuals the increase was even sharper, rising from 11.1% in the New Kingdom to 69.0% in the post-New Kingdom period (χ^2=9.299, df=1, p=0.002). In contrast, in male individuals, rates were similar in the lumbar spine, affecting 50.0% of New Kingdom and 48.0% of post-New Kingdom males. The difference between male and female lumbar spines in the New Kingdom period proved to be statistically significant at a 10% confidence level (χ^2=3.085, df=1, p=0.079).

8.9.5. Schmorl's nodes

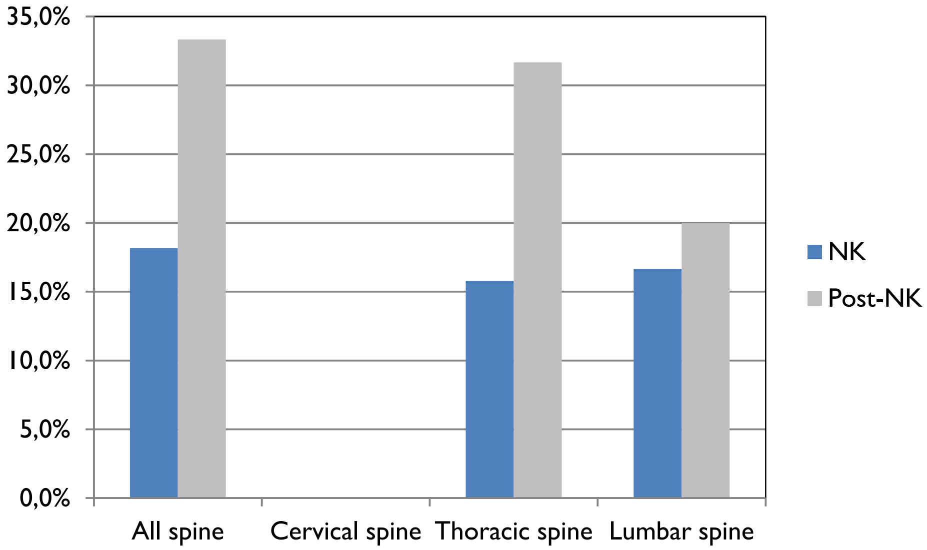

Figure 8.47 Diachronic comparison of Schmorl's nodes between New Kingdom and post-New Kingdom individuals

		All spine		Cervical		Thoracic		Lumbar	
		NK	Post-NK	NK	Post-NK	NK	Post-NK	NK	Post-NK
Young adults	n/N	0/8	14/31	0/8	0/29	0/8	11/29	0/7	9/30
	%	-	45.2	-	-	-	37.9	-	30.0
Middle adults	n/N	2/8	6/23	0/5	0/16	1/5	6/19	1/5	2/21
	%	25.0	26.1	-	-	20.0	31.6	20.0	9.5
Old adults	n/N	0/1	2/8	0/1	0/7	0/1	1/7	0/1	1/6
	%	-	25.0	-	-	-	14.3	-	16.7
Indifferent	n/N	2/5	1/7	0/5	0/6	2/5	1/5	2/5	0/3
	%	40.0	14.3	-	-	40.0	20.0	40.0	-
Total	n/N	4/22	23/69	0/19	0/58	3/19	19/60	3/18	12/60
	%	18.2	33.3	-	-	15.8	31.7	16.7	20.0

Table 8.61 Age-related prevalence of Schmorl's nodes in the New Kingdom and post-New Kingdom samples

The age-related prevalence for Schmorl's nodes is presented in Figure 8.47 and Table 8.61. Rates were generally low with 18.2% of all New Kingdom individuals and 33.3% of all post-New Kingdom individuals being affected. While no Schmorl's nodes were detected in the cervical spine, the highest rates were observed in the post-New Kingdom thoracic spine. In diachronic comparison, an increase during the post-New Kingdom period could be observed in the thoracic and the lumbar sections of the spine.

8.9.6. Erosive joint disease

Evidence of erosive forms of joint disease were very rare and not systematically analysed in the sample. Differential diagnosis of the conditions will be discussed in more detail in Sections 9.7.3 and 9.7.4. The observed examples are only presented in descriptive form.

8.9.6.i. Potential evidence for gout

Three post-New Kingdom individuals (Sk201-2, Sk201-3, Sk201-5) displayed smooth walled circular erosions of 4–6mm diameter in the tarsals and metatarsals (see Table 8.62). In the tarsals, the lesions were located extra-articular on the superior and interproximal surfaces. In the 1st metatarsal, changes were observed on the medial side of the distal joint surface. Radiographs of the right *os naviculare* and left lateral *os cuneiforme* confirmed a sclerotic margin.

Individual	Affected elements	Analytical methods
Sk201-2	left foot: cuboid left, lateral cuneiforme, 1st metatarsal left right foot: naviculare, lateral cuneiforme (see Figure III.105, III106)	macroscopic radiography
Sk201-3	left foot: medial and lateral cuneiforme right foot: medial cuneiforme, naviculare	macroscopic
Sk201-5	right foot: medial and lateral cuneiforme	macroscopic

Table 8.62 Erosive periarticular-changes possibly associated with gout

8.9.6.ii. Sero-negative spondylarthropathies

Evidence for sero-negative spondylarthropaties were very rare. One post-New Kingdom male individual (Sk238) showed extensive ankylosis in the cervical, thoracic and lumbar spine (see Figures III.107, III.108). Unfortunately, this single burial was thoroughly disturbed and the skeleton could only be recovered completely disarticulated, fragmented and incomplete. Even though the spine was largely complete, the vertebrae were highly fragmented. Fusion involved the neural arches, spinous processes and vertebral bodies even though fusion in the bodies appeared to be more comprehensive. Infrequently, "skip" lesions were observed, occurring in C4/C5. The most extensive fusion occurred in the thoracic spine, but L5 and S1 were not fully fused. Fusion was also observed in the sacro-iliac joint on both sides even though neither of the joints were completely preserved. Furthermore, fusion also affected the costo-vertebral joints.

8.9.7. Diffuse Idiopathic Skeletal Hyperostosis (DISH)

Only two tentative example of DISH could be identified in a New Kingdom middle adult male individual (Sk301-4) and an adult male dating to the post-New Kingdom period (Sk305-9). Differential diagnosis will be explored in more detail in Section 9.7.5. Ossification and fusion of the anterior spinal ligament on the right side of the vertebral bodies was observed between Th3 and Th7 as well between Th8 and Th12 (see Figure III.109). The osteophytes in the upper portion of the thoracic spine were not fully fused even though this might be due to the person having an early stage of the disease at death. In addition, fusion affected the costo-vertebral joints of the 4^{th} and 5^{th} rib on both sides of the body. Initial formation of enthesophytes was also observed on ribs 6–12. The substantial osteophytes on the right side of the lower thoracic vertebrae of Sk305-9 may also indicate DISH (see Figure III.110). However, the individual was recovered from a commingled context, therefore only isolated vertebrae remained present and the diagnosis has to remain tentative.

8.10. Trauma

Trauma was analysed for all individuals excluding those under five years of age. Prevalence rates were calculated for the number of elements present for each bone type (left and right combined) as well as according to the number of individuals affected with the elements preserved for observation. In long bones and clavicles, bones were divided into three sections (proximal/medial – medial – distal/lateral third) and analysed separately.

8.10.1. Skull fractures

Table 8.63 presents the frequencies for skull fractures. While they were relatively common during the post-New Kingdom period, New Kingdom individuals only rarely suffered trauma to the skull. The area of the skull most commonly affected was the frontal bone (see Figure III.112–115) with one (4.5%) example during the New Kingdom period and five examples (8.8%) during the post-New Kindom period. In the post-New Kingdom period further skull fractures were observed in the parietal (3/104, 2.9%) and in the nasal bones (3/46, 6.5%, Figure III.115). All fractures were recorded as well healed. As for trauma type, all of the observed fractures to the cranial vault represented small, circular depression fractures.

		NK	Post-NK	Total
Frontal bone	**n/N**	1/22	6/57	7/79
	%	4.5	10.5	8.9
Parietal bone	**n/N**	0/42	3/104	3/146
	%	-	2.9	2.1
Nasal bones	**n/N**	0/12	3/46	3/58
	%	-	6.5	5.2

Table 8.63 Skull fracture, according to the number of bones affected

8.10.2. Long bone fractures

		P1/3		M1/3		D1/3	
		NK	Post-NK	NK	Post-NK	NK	Post-NK
Humerus	**n/N**	0/20	2/117	0/34	0/129	0/37	0/129
	%	-	1.7	-	-	-	-
Radius	**n/N**	0/36	0/120	0/33	0/122	0/32	5/112
	%	-	-	-	-	-	3.8
Ulna	**n/N**	0/37	0/140	1/36	0/124	1/33	5/115
	%	-	-	2.8	-	3.0	4.3
Femur	**n/N**	0/39	1/120	0/39	0/126	0/36	0/135
	%	-	0.8	-	-	-	-
Tibia	**n/N**	0/33	0/140	0/33	0/146	0/34	0/139
	%	-	-	-	-	-	-
Fibula	**n/N**	0/26	0/119	0/30	0/120	0/30	0/118
	%	-	-	-	-	-	-

Table 8.64 Prevalence of long bone fractures according to the number of bone sections available for each diaphyseal section

Table 8.64 presents prevalence rates for long bone fractures calculated for the number of elements with a preservation score of >1 available for each diaphyseal section of the bone. Rates for the number of individuals with bones preserved are presented seperately in Section 8.10.5. Long bone fractures were generally not very common in both time periods, even though the number is higher in the post-New Kingdom period, with 13, compared to two in the New Kingdom period. The most commonly affected bones were the radius (post-New Kingdom: five individuals, 9.8%) and ulna (New Kingdom: two individuals, 11.8%, see Figures III.129, III.131). Humerus fractures were only observed in two post New Kingdom individuals (4.3%, see Figures III.130, III.131). With the exception of one femur fracture in a post-New Kingdom individual (see Figures III.134), the lower extremity was not affected at all. With regard to section of the bone affected, the most common sites affected by fractures were the distal radius (post-New Kingdom: 3.8%) and ulna (New Kingdom: 3.0%; post-New Kingdom: 4.3%).

8.10.3. Fractures of the thorax

		NK	Post-NK	NK	Post-NK	NK	Post-NK
		p1/3		m1/3		d1/3	
Clavicle	n/N	0/22	2/107	1/31	0/126	0/26	1/107
	%	-	1.9	3.2	-	-	0.9
		Acromion		Scapular blade			
Scapula	n/N	1/26	1/118	0/26	1/106		
		3.8	0.8	-	0.9		
		Shafts					
Ribs	n/N	4/275	30/961				
	%	1.5%	3.1				
		Ilium		Ischium		Pubis	
Pelvis	n/N	0/25	2/105	0/26	0/92	0/22	2/82
	%	-	1.9	-	-	-	2.4
		Manubrium		Corpus			
Sternum	n/N	0/2	1/18	0/3	1/20		
	%	-	5.6	-	5.0		

Table 8.65 Fractures of the bones of the trunk (bones affected compared to the total observed)

Fractures to the skeletal elements of the trunk were generally more uncommon (see Table 8.65) but did involve some more unusual fracture locations such as in the sternum, pelvis and scapula. Prevalence was slightly higher during the post-New Kingdom period. In the clavicles, four fractures were observed, affecting one New Kingdom individual (middle shaft, 3.2%) and three post-New Kingdom individuals (proximal shaft: 1.9% and distal shaft: 0.9%, see Figures III.117, III.118). Scapula fractures (see Figures III.119, III.120) were equally rare, affecting one New Kingdom (3.8%) and two post-New Kingdom individuals (0.9%). Two examples of sternum fractures (see Figures III.120) were observed in a post-New Kingdom individual, with fractures of the *manubrium sterni* (5.6%) and *corpus sterni* (5.0%).

Fractures of the pelvis were observed in two post-New Kingdom individuals with a total number of four examples (see Figures III.132, III.133). While the iliac blade was fractured twice (5.6% of observable elements) and the pubic bone was also fractured twice, but in the same individual (2.4% of observable elements).

		Carpal/tarsal		Metacarpus/tarsus		Phalanges	
		NK	**Post-NK**	**NK**	**Post-NK**	**NK**	**Post-NK**
Hands	**n/N**	0/173	0/584	0/115	8/422	1/252	4/1164
	%	-	-	-	1.9	0.4	0.3
Feet	**n/N**	0/137	0/582	0/67	7/411	1/173	4/641
	%	-	-	-	1.7	0.6	0.6

Table 8.66 Fractures of the hand and foot bones (percentages given based on the total number of bones preserved for observation)

In the hands, no fractures were observed in the carpals for both time periods (Table 8.66). Fractured metacarpals were more common, affecting 1.9% (8) of metacarpals in the post-New Kingdom period. Equally uncommon were fractures in the feet. Tarsals were unaffected in both New Kingdom and post-New Kingdom individuals. As for metatarsals, no fractures were observed in New Kingdom individuals, whereas 7 (1.7%) were found in post-New Kingdom individuals.

8.10.4. Fractures of the spine

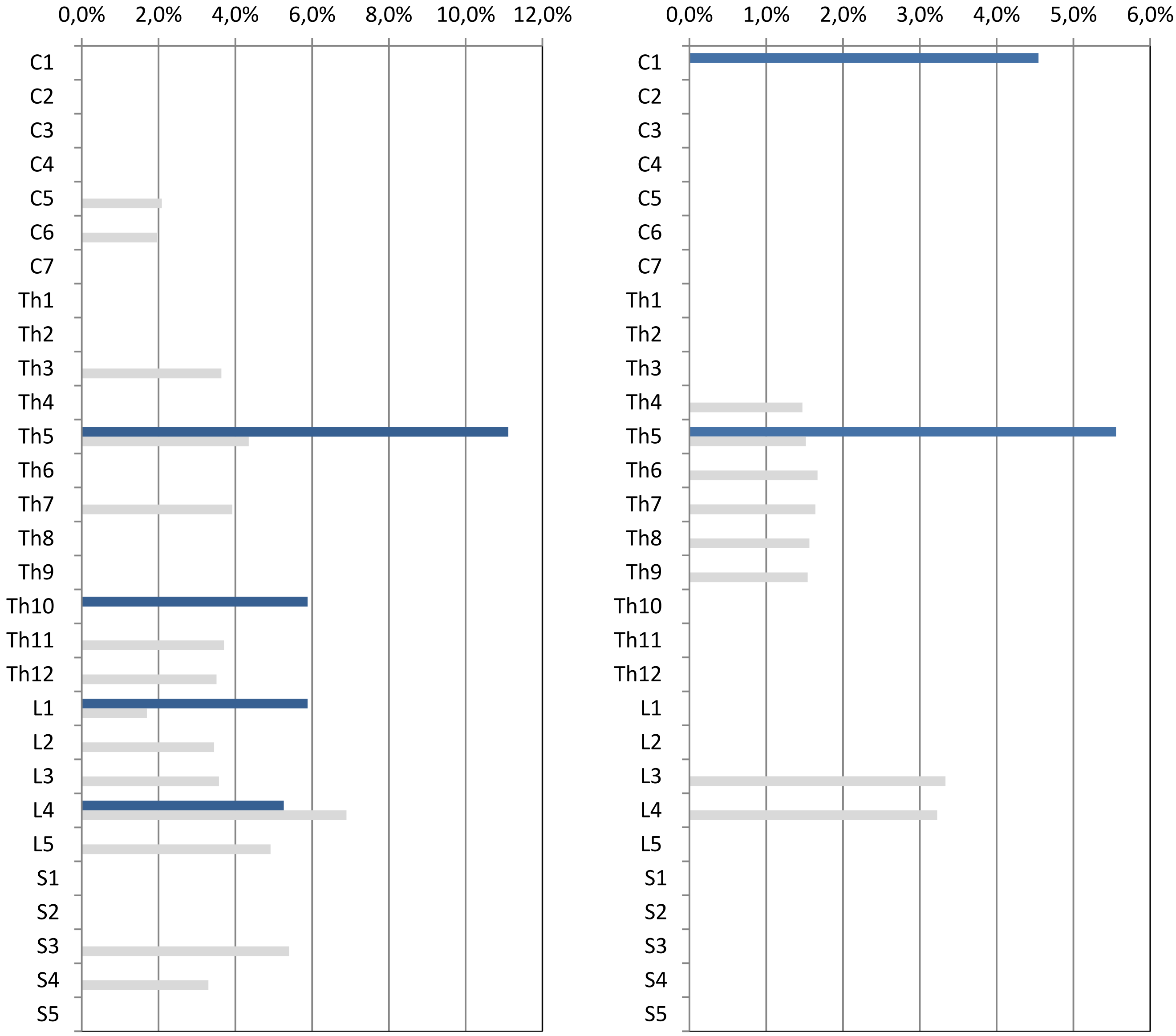

Figure 8.48 Spinal fractures: left: vertebral bodies; right: neural arches (blue bars: New Kingdom, grey bars: post-New Kingdom)

		Body		Arch			Body		Arch	
		NK	Post-NK	NK	Post-NK		NK	Post-NK	NK	Post-NK
C1	n/N	0/16	0/41	1/22	0/49	**Th9**	0/18	0/57	0/22	1/65
	%	-	-	4.5	-		-	-	-	1.5
C2	n/N	0/17	0/50	0/18	0/60	**Th10**	1/17	0/52	0/21	0/63
	%	-		-	-		5.9	-	-	-
C3	n/N	0/17	0/38	0/19	0/45	**Th11**	0/18	2/54	0/21	0/66
	%	-	-	-	-		-	3.7	-	-
C4	n/N	0/17	0/45	0/19	0/53	**Th12**	0/18	2/57	0/20	0/64
	%	-	-	-	-		-	3.5	-	-
C5	n/N	0/19	1/48	0/21	0/55	**L1**	1/17	1/59	0/20	0/65
	%	-	2.1	-	-		5.9	1.7	-	-
C6	n/N	0/21	1/51	0/21	0/60	**L2**	0/19	2/58	0/24	0/65
	%	-	2.0	-	-		-	3.4	-	-
C7	n/N	0/19	0/51	0/21	0/60	**L3**	0/20	2/56	0/25	2/60
	%	-	-	-	-		-	3.6	-	3.3
Th1	n/N	0/18	0/52	0/20	0/62	**L4**	1/19	4/58	0/23	2/62
	%	-	-	-	-		5.3	6.9	-	3.2
Th2	n/N	0/17	0/52	0/19	0/64	**L5**	0/21	3/61	0/23	0/67
	%	-	-	-	-		-	4.9	-	-
Th3	n/N	0/17	2/55	0/19	0/66	**S1**	0/11	0/42	0/15	0/46
	%	-	3.6	-	-		-	-	-	-
Th4	n/N	0/13	0/54	0/16	1/68	**S2**	0/11	0/38	0/15	0/43
	%	-	-	-	1.5		-	-	-	-
Th5	n/N	1/9	1/23	1/18	1/66	**S3**	0/11	2/37	0/16	0/41
	%	11.1	4.3	5.6	1.5		-	5.4	-	-
Th6	n/N	0/10	0/22	0/19	1/60	**S4**	0/11	1/30	0/16	0/35
	%	-	-	-	1.7		-	3.3	-	-
Th7	n/N	0/18	2/15	0/22	1/61	**S5**	0/10	0/26	0/13	0/31
	%	-	3.9	-	1.6		-	-	-	-
Th8	n/N	0/17	0/54	0/21	1/64	**total**	4/466	26/1372	2/599	10/1666
	%	-	-	-	1.6		0.9	1.9	0.4	0.6

Table 8.67 Prevalence of fractures of the vertebral bodies and neural arches

Frequencies for fractures of the vertebral bodies and neural arches were calculated for the number of elements preserved and are presented seperately for each vertebra in Figure 8.48 and Table 8.67. Generally, fractures of the spine (see Figures III.122–III.129) were observed more frequently in post-New Kingdom individuals than in New Kingdom individuals (bodies: New Kingdom: 0.9%, post-New Kingdom 0.4%, neural arches: New Kingdom: 0.4%, post-New Kingdom: 0.6%). In both time periods, fractures of the vertebral bodies were by far more common than fractures of the neural arches. The most commonly affected section of the spine was the lower thoracic and lumbar sections, and the highest frequencies were observed in L4 and L5.

8.10.5. Fractures combined

		NK	Post-NK	Total
Skull	%	1/23	9/71	10/94
	n/N	4.3	12.7	10.6
Clavicle	%	1/7	3/39	4/46
	n/N	14.3	7.3	8.7
Scapula	%	1/10	2/48	3/58
	n/N	9.1	4.0	5.2
Humerus	n/N	0/15	2/47	2/62
	%	-	4.3	3.2
Radius	n/N	0/15	5/48	5/63
	%	-	9.8	7.9
Ulna	n/N	2/17	5/52	7/69
	%	11.8	9.1	10.1
Hands	n/N	1/16	8/55	9/71
	%	6.3	14.5	12.7
Sternum	n/N	0/3	1/22	1/25
	%	-	1.7	4.0
Ribs	n/N	4/25	15/72	19/97
	%	16.0	20.8	19.6
Cervical spine	n/N	0/15	2/48	2/63
	%	-	4.2	3.2
Thoracic spine	n/N	2/17	11/58	13/75
	%	11.8	19.0	17.3
Lumbar spine	n/N	2/18	8/53	10/71
	%	11.1	15.1	14.1
Sacrum	n/N	0/20	2/35	2/55
	%	-	5.7	3.6
Pelvis	%	0/11	2/43	2/54
	n/N	-	4.7	3.7
Femur	%	0/19	1/59	1/78
	n/N	-	1.7	1.3
Tibia	%	0/13	0/57	0/70
	n/N	-	-	-
Fibula	%	0/12	0/46	0/58
	n/N	-	-	-
Patella	n/N	0/8	2/34	2/42
	%	-	-	4.8
Feet	n/N	1/10	7/53	7/63
	%	10.0%	13.2	11.1

Table 8.68 Prevalence of fractures (individuals affected with the bone preserved for observation)

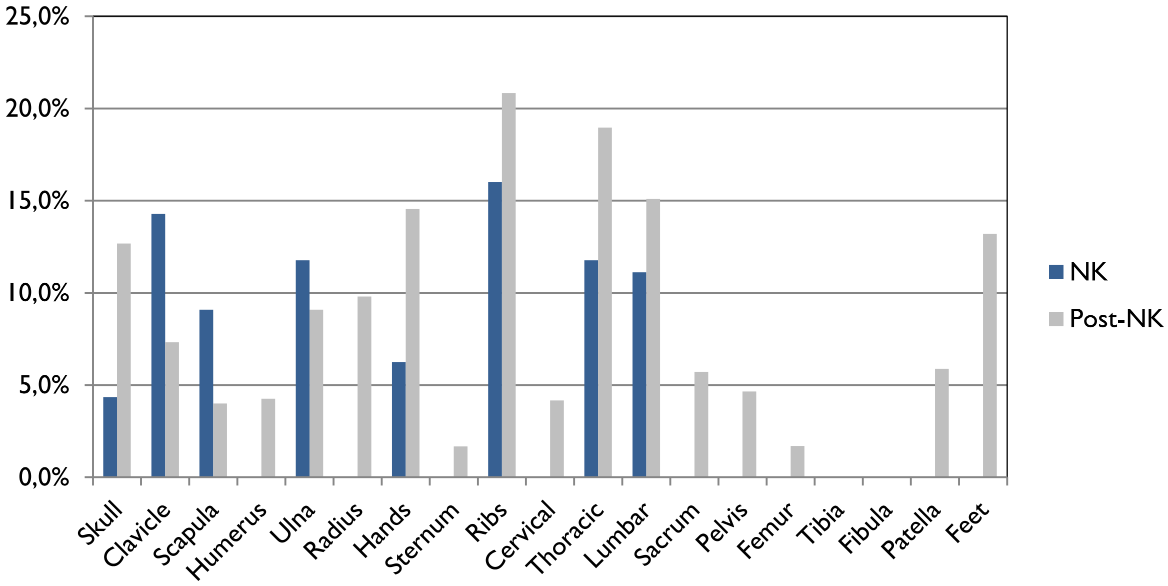

Figure 8.49 Comparison of fracture frequencies (values for individuals affected with parts preserved)

Figure 8.49 and Table 8.68 present the fracture rates for all bone elements or groups of elements based on the respective number of individuals with elements of both sides preserved. Individuals with fractures but the corresponding antimere missing were also included. In groups of multiple skeletal elements (ribs, spine, hands, feet), the number of individuals, not number of bones, affected with fractures was considered. In general, fractures were more common in the post-New Kingdom than in the New Kingdom period. By far the most commonly affected elements were the ribs (19.3%), thoracic (17.3%) and lumbar spine (14.1%). This could be observed for both time periods and even the diachronic comparison revealed a marked increase of rib and spinal fractures in the post-New Kingdom period. However, a χ^2-test did not reveal any statistical significance.

Skull fractures were also not uncommon, affecting 10.6% of the total population. The diachronic comparison revealed an increase from 4.3% to 12.7% in the post-New Kingdom period, even though again this difference was not statistically significant. Fractures to the clavicle and shoulder blade affected 8.7% and 5.6% of individuals, respectively, and both rates were higher in the New Kingdom than in the post-New Kingdom period, even though the raw number of fractures and individuals was quite small. In the pelvic girdle, two fractures to the sacrum (3.6%) and two fractures to the innominate bone (3.5%) were observed in post-New Kingdom individuals. In New Kingdom individuals fractures in this area were absent. Fractures in the hands and feet were also only observed in post-New Kingdom individuals, affecting 14.5% and 13.2% of individuals respectively.

8.10.6. Fracture "activity"

		NK	Post-NK	Total
Healing	**n**	2	12	14
	%	12.5	9.8	11.6
Healed	**n**	14	110	124
	%	87.5	90.2	88.4
Total	**N**	16	122	138

Table 8.69 "Activity" status of fractures (n= number of fractures)

Table 8.69 gives a summary of the "activity" status of the observed fractures. The majority of fractures observed at Amara West were healed. Only 12.5% of fractures of the New Kingdom sample and 9.8% of the post-New Kingdom fractures were not fully healed at the time of death of the individual. Differences between the two time periods were only minor. Healing fractures were only observed in adult individuals.

		Healing		Healed			Healing		Healed	
		NK	**Post-NK**	**NK**	**Post-NK**		**NK**	**Post-NK**	**NK**	**Post-NK**
Skull	**n**	0	1	1	10	**Ribs**	1	7	3	28
	%	-	0.8	6.3	8.2		6.3	5.7	18.8	23.0
Clavicle	**n**	0	0	1	3	**Spine**	1	4	4	32
	%	-	-	6.3	2.5		6.3	3.3	25.0	26.2
Scapula	**n**	0	0	1	2	**Pelvis**	0	0	0	2
	%	-	-	6.3	1.6		-	-	-	1.6
Humerus	**n**	0	0	0	2	**Femur**	0	0	0	1
	%	-	-	-	1.6		-	-	-	0.8
Ulna	**n**	0	0	2	5	**Tibia**	0	0	0	0
	%	-	-	12.5	4.1		-	-	-	-
Radius	**n**	0	0	0	0	**Fibula**	0	0	0	0
	%	-	-	-	-		-	-	-	-
Hands	**n**	0	0	1	12	**Patella**	0	0	0	2
	%	-	-	6.3	9.8		-	-	-	1.6
Sternum	**n**	0	1	0	0	**Foot**	0	1	1	9
	%	-	0.8	-	-		-	0.8	6.3	7.4
						Total	**2**	**14**	**14**	**106**
							12.5	**11.8**	**87.5**	**86.9**

Table 8.70 Comparison of healed and unhealed fractures by anatomical location

Table 8.70 further examines the location of fractures that were not fully healed. The majority of unhealed fractures were observed in the ribs and spine. No significant differences were detected between the New Kingdom (ribs: 6.3%, spine 6.3%) and post-New Kingdom (ribs: 5.7%, spine: 3.3%). Further fractures which were not fully healed by the time the individual had died were observed in one skull, one sternum and one metatarsal (all of post-New Kingdom date).

8.11. Neoplasms

8.11.1.i. Metastatic carcinoma

Due to the small number, no systematic analysis was carried out for evidence of neoplasm. Only one individual from the New Kingdom period, Sk244-8 displayed skeletal signs consistent with a diagnosis of metastatic carcinoma (Binder *et al.*, 2014). The skeleton was almost complete with largely intact bone surfaces. The long bones and skull of the skeleton suffered little to moderate post-mortem breakage. In contrast, the elements of the axial skeleton were very friable and fragmentary due to the pathological conditions present. Taphonomic damage, mainly due to salt precipitation from the surrounding soil, led to some erosion on the skull vault. A multitude of small round to oval-shaped osteolytic lesions ranging in diameter from between 3–4 and 15mm in size were observable in the scapulae, clavicles, sternum, vertebrae and pelvis (see Figure 8.50, III.135–142). For a comprehensive description of the lesions see Binder *et al.* (2014). Upon radiographic examination, further defects which had not penetrated the bone surface could be observed. Several lytic lesions also featured small amounts of new bone formation (see Figures III.140–III.141). In the bone elements with large amounts of cancellous bone, in particular the bodies of thoracic and lumbar vertebrae as well as the sacrum and pelvis, in several cases a high degree of fragmentation left detection and description of individual lesions impossible.

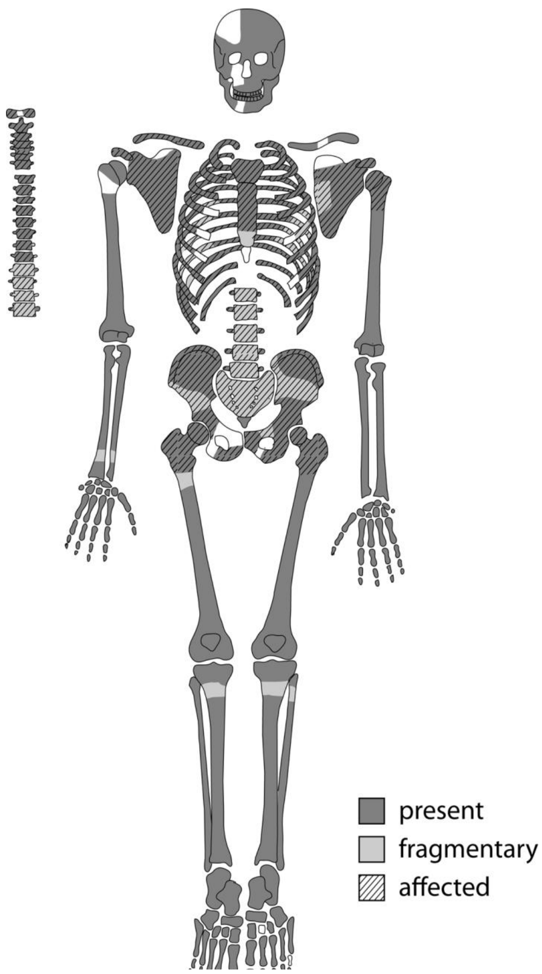

Figure 8.50 Skeleton Sk244-8 with areas present and affected by pathological changes

8.12. Cardiovascular disease

Five individuals featured calcified structures potentially representing calcified arteries. The results are summarised in Table 8.71. A detailed description is given in Binder & Roberts, 2014. Images of the calcifications are presented in Figures III.143–150.

8.12.1. New Kingdom

Sk244-4

Within the heavily fragmented chest cavity of a middle aged adult male individual one large calcified plaque was observed. The plaque SS68 was very hard, yellow coloured and of irregular, oval shape (l: 23.0mm t: 0.9mm, see Figure 8.51). In cross-section the plaque is semi-circular. Scanning electron microscopy (SEM) characterisation showed a very dense, homogenous substance. Energy-Dispersive X-Ray Spectroscopy (EDS) carried out to analyse the material, confirmed a calcified nature. Radiography revealed a dense internal structure. Digital microscopic imaging (30x) of the surface similarly showed a smooth, homogenous texture.

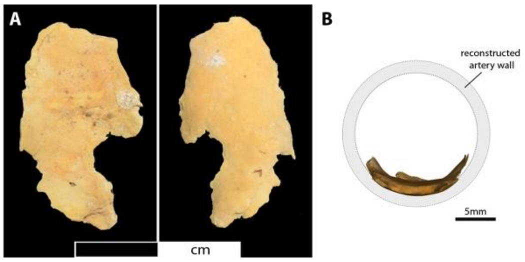

Figure 8.51 Calcified plaque SS68

Sk244-6

Associated with a middle adult male five differently sized calcified plaques were recovered along the lower cervical and upper thoracic spine in the area between C6 and Th2 and within the chest cavity (see Figures III.143, III.144). Despite some post-depositional disarticulation in the thorax area due to looting and re-use, the elements were still largely in an anatomically correct position. Therefore, only minor displacement of the calcifications was possible. The calcifications had a hard texture and yellow colour. The largest (SS69a) had an irregular elongated sub-cylindrical shape, 17.4x10mm in length and width, and a thickness of 1.3mm. High magnification (35x) again showed a homogenous structure with smooth edges. The smaller structures recovered from the vicinity of the cervical and upper thoracic spine ranged in size from between 9.0x12mm (SS69b) and 4.4x5.0mm with a thickness of 0.6mm. Further pathological findings in this individual include evidence for chronic infection of the lungs, as indicated by new bone formation on the visceral surfaces of the shafts of three right and four left ribs.

8.12.2. Post-New Kingdom

Sk243-3

A middle adult female from a non-elite tomb featured a small calcification (SS67: 14.6 x 8.9mm, 1.1mm in thickness) in the upper thoracic area to the right of the spine (see Figures III.145, III.146). As the chamber was not backfilled after the burial and the individual was not entirely supine it seems likely that the calcified structure may have been slightly displaced from its original position. In addition to a small healed depression fracture on the frontal bone, remodelled new bone formation was observed on the visceral aspect of the shafts of five left and six right ribs. Moderate to severe periodontal disease was observed as well.

Sk237

Eight round to oval shaped hard, yellow calcifications of varying sizes were recovered from the abdominal area on top of the lumbar vertebrae of a middle adult female individual from a post-New Kingdom, non-elite tomb (see Figure III.146). The individual was buried in a supine position, the calcified structures were orientated parallel to the body axis. The two largest examples were of elongated oval shape (SS37a: 18.7mm x 7.3mm, thickness 1.2mm; SS37b: 15.5mm x 5.9mm, thickness: 1.0mm, see Figure III.147) with a curved cross section. The smaller fragments ranged in size from between 8.6x7.7mm and 6.0x5.0mm.

Sk305-4

This female middle adult individual was recovered from a double-chambered tomb in the elite cemetery at Amara West. A string of whitish, round calcifications was found running along the medial side of the right femur from the area of the femoral neck inferiorly over a length of 25cms (see Figures III.148, III.149). The remaining fragments were of whitish colour, up to 14mm long. The walls reached a thickness of up to 0.4–0.5mm. In contrast to the other calcifications the full circumference was calcified and preserved intact throughout most of the length of the lesion, with a diameter of 4–5mm.

Skeleton number	Dating	Sex	Age	Location of calcified tissue	Dimensions (in mm)	Likely blood vessel involved	Analytical methods
Sk244-4	1300–1070BC	M	36–50 yrs	chest	SS68: 2.3x1.5, t: 0.9, (Figure 8.51)	Thoracic aorta	Radiography SEM EDS Digital microscopy
Sk244-6	1300–1070BC	M	36–50 yrs	chest	SS69a: 17.4x10.0, t: 1.3	Thoracic aorta	Radiography SEM Digital microscopy
					SS69b: 9.0x11.0, t: 0,6	Subclavian artery	Radiography
Sk243-3	1000–800BC	F	36–50 yrs	chest	SS67: 14.6 x 8.9, t: 1.1	Aorta	Radiography
Sk237	1000–800BC	F	36–50 yrs	abdominal area (L3–S1)	SS37a 18.7 x 7.3, t 1.2 SS37b 15. x 5.9, t: 1.0	Iliac artery	Radiography
Sk305-4	1000–800BC	F	36–50 yrs	left femur	SS5: l: 2–14, t: 0.4–0.5, d: 0.4–0.5	Femoral artery	Radiography

Table 8.71 Details of the characteristics of the individuals with arterial calcifications

8.13. Stable Isotope Results

8.13.1. Carbon and nitrogen isotope ratios from bone and tooth collagen

Only four of the samples tested yielded enough collagen to allow for further analysis of carbon and nitrogen isotope ratios (see Table 8.72).

Sample No.	Skeleton No	Date	Tomb type	Sample weight (mg)	Sample area	collagen yield (mg)
AW3	Sk201-2	post-NK	chamber	190	femur right	**2.7**
AW4	Sk201-3	post-NK	chamber	203	humerus	0.1
AW5	Sk201-4	post-NK	chamber	200	fibula left	0.0
AW6	Sk201-5	post-NK	chamber	183	fibula right	0.0
AW7	Sk211-3	post-NK	niche	181	femur right	0.4
AW8	Sk214	post-NK	niche	201	tibia right	0.0
AW9	Sk216-1	post-NK	niche	198	fibula right	0.0
AW10	Sk226	post-NK	niche	199	fibula right	0.0
AW11	Sk220	post-NK	niche	183	radius right	0.0
AW12	Sk234-2	NK	chamber	190	femur right	0.8
AW13	Sk234-5	NK	chamber	200	femur left	0.0
AW14	Sk234-12	NK	chamber	182	femur right	0.0
AW15	Sk234-16	NK	chamber	177	tibia right	0.1
AW16	Sk237	post-NK	niche	182	femur right	0.58
AW17	Sk238	post-NK	niche	206	femur	0.46
AW18	Sk240	post-NK	niche	171	fibula	0.0
AW19	Sk300-1	post-NK	chamber	181	left rib	**4.93**
AW20	Sk300-5	post-NK	chamber	167	femur right	0.43
AW21	Sk301-3	NK	chamber	193	femur right	0.07
AW22	Sk301-4	NK	chamber	185	femur right	0.0
AW23	Sk305-6	post-NK	chamber	193	femur right	0.0
AW24	Sk201-4	post-NK	chamber	163	llM3	0.0
AW25	Sk234-10	NK	chamber	146	llM2	0.98
AW26	Sk300-1	post-NK	chamber	180	ulM2	0.76
AW27	Sk216-3	post-NK	niche	190	ulM3	**1.97**
AW28	Sk305-3	post-NK	chamber	202	llM3	0.0
AW29	Sk305 [9068]	post-NK	chamber	184	ulM3	**2.8**

Table 8.72: Collagen yields for human samples from Amara West (NK=New Kingdom, post-NK=post-New Kingdom, sufficient yields indicated in bold letters)

8.13.2. Carbon and oxygen isotope ratios from enamel apatite

Carbon and oxygen isotope ratios were obtained from 23 human and ten animal samples from Amara West. A further nine samples were analysed by Buzon at Purdue University as part of the wider "Health and Diet in Ancient Nubia through Climate and Political Change" project and are included in the overall presentation of data. The detailed results are given in Table 8.73 and plotted in Figure 8.52. For the human samples, $\delta^{13}C$ values range between -13.31‰ and -12.43‰ in New Kingdom individuals, and -14.21‰ and -11.94‰ in post-New Kingdom individuals (see Table 8.74). The range for $\delta^{18}O$ in humans was 31.97‰ and 32.73‰ (New Kingdom) and 28.55‰ and 36.22‰ (post-New Kingdom, see Table 8.76). Both groups are relatively homogenous in $\delta^{13}C$ values (x-axis of the plot, Figure 8.52) and did not reveal any significant differences in diachronic comparison. In contrast, $\delta^{18}O$ values (plotted on the y-axis in Figure 8.52) have shown to be distinctively more varied. The difference between the two human samples proved to be significantly different ($p=0.010$) based on a Mann-Whitney U-test.

In animals the observed ranges of both carbon and oxygen isotopes were far greater, both within as well as between the three species pig, cattle and sheep/goat. For both isotopes values of the animal samples by far exceed those of the human samples.

Sample No	Skeleton-No/ Context No.	Date	Tomb type	Tooth type	Sex	δ13C V-PDB	δ18O VPDB	δ18O VSMOW
Human samples								
AW1	317-1	post-NK	chamber	um3	F	-12.24	2.75	33.74
AW2	309 [8155]	post-NK	chamber	m3	?	-13.44	2.55	33.54
AW3	319-2	NK	chamber	ulM3	?	-12.43	1.50	32.45
AW4	239	post-NK	niche	lrm3	M	-12.01	1.86	32.83
AW5	309-7	NK	chamber	um3	F	-13.25	1.77	32.73
AW6	314-14	post-NK	chamber	urm3	inf	-12.30	3.09	34.10
AW7	309-6	NK	chamber	lum3	F	-12.60	1.03	31.97
AW8	314-3	post-NK	chamber	rlm3	M	-13.35	3.51	34.52
AW9	224	post-NK	niche	m3	M	-12.34	4.06	35.09
AW10	216-1	post-NK	niche	ulm3	F	-12.39	0.25	31.17
AW11	305-3	post-NK	chamber	llM3	F	-13.49	1.54	32.50
AW12	301-2	post-NK	chamber	llm3	inf	-12.79	2.36	33.34
AW13	201-4	post-NK	chamber	llm3	M	-13.45	-0.13	30.77
AW14	216-3	post-NK	niche	llm3	inf	-12.55	0.72	31.65
AW15	243	post-NK	chamber	m2	?	-13.60	2.68	33.68
AW 17	301 [8085]	post-NK	chamber	urM3	?	-12.35	1.95	32.92
AW18	234-10	NK	chamber	llm2	F	-12.70	1.58	32.54
AW19	300-1	post-NK	chamber	um2	inf	-13.40	5.15	36.22
AW20	305 [9068]	post-NK	chamber	ulM3	?	-14.09	2.21	33.19
AW32	244-5	NK	chamber		F	-13.31	1.09	32.04
AW33	243 [9282]	post-NK	chamber		?	-14.21	-2.29	28.55
AW34	244-3	NK	chamber		M	-13.28	1.42	32.37
AW35	243-17	post-NK	chamber			-12.93	2.29	33.27
9001*	200 [9001]	post-NK	chamber		?P	-12.56	3.19	34.21
9019*	201 [9019]	post-NK	chamber	llM3	?	-12.55	3.03	34.04
8005*	300 [8005]	post-NK	chamber	?	?	-13.00	2.87	33.88
CB 9034*	211 [9034]	post-NK	chamber	P	?	-12.79	2.00	32.98
9022*	210 [9022]	post-NK	niche	M1	?	-11.94	3.00	34.01
9026*	211 [9026]	post-NK	niche	urI2	?	-12.49	2.99	34.00
9033*	211-2	post-NK	niche	urM2	M	-13.30	3.02	34.03
Animal samples								
AW21		cattle	settlement	-	-	-10.74	-1.12	29.76
AW22	D13.3.2 [3025]	cattle	settlement	-	-	-6.52	2.18	33.15
AW23	E13.16.2 [5488]	cattle	settlement	-	-	-12.56	4.55	35.60
AW24	E13.7.2 [5516]	pig	settlement	-	-	-12.70	7.45	38.59
AW25	E13.4.5 [4461]	pig	settlement	-	-	-10.47	0.79	31.73
AW26	E13.4.5 [4635]	cattle	settlement	-	-	-13.68	4.87	35.93
AW27	D12.5.11 [2320]	cattle	settlement	-	-	1.18	4.24	35.28

AW28	D12.10.7 [2177]	cattle	settlement	-	-	-10.12	10.68	41.92
AW29	E12/ [2233]	cattle	settlement	-	-	-8.27	7.73	38.88
AW30	D12.10.6 [2186]	cattle	settlement	-	-	-9.61	7.39	38.53
AW31	D12.10.7 [2118]	sheep	settlement	-	-	-8.76	8.32	39.49
AW-R-1*	?	pig	settlement	-	-	-14.45	4.27	35.32
AW-R-2*	?	sheep	settlement	-	-	-9.69	7.94	39.11
AW-R-3*	?	sheep	settlement	-	-	-10.64	8.18	39.35

Table 8.73 Carbon and oxygen (carbonate, $O_{c;}$ phosphate O_p) composition of apatite in teeth from human and animal samples from Amara West (animal samples all of New Kingdom date, * data obtained by Buzon at Purdue University)

		δ^{13}C				**δ^{18}O**			
	n	**Min (‰)**	**Max (‰)**	**Mean (‰)**	**SD (‰)**	**Min (‰)**	**Max (‰)**	**Mean (‰)**	**SD (‰)**
Human New Kingdom	6	-13.31	-12.43	-12.93	0.40	31.97	32.73	32.35	0.29
Human post-New Kingdom	24	-14.21	-11.94	-12.90	0.63	28.55	36.22	33.26	1.54
Pig	7	-14.45	-10.47	-12.54	2.00	31.73	38.59	35.21	3.43
Cattle	3	-13.68	1.18	-8.79	4.62	29.76	41.92	36.13	3.73
Sheep/Goat	3	-10.64	-8.76	-9.70	0.94	39.11	39.49	35.21	0.19

Table 8.74 Minimum, maximum, mean and standard deviation (sd) for δ^{13}C and δ^{18}O in human and animal samples from Amara West (animal samples are all of New Kingdom date)

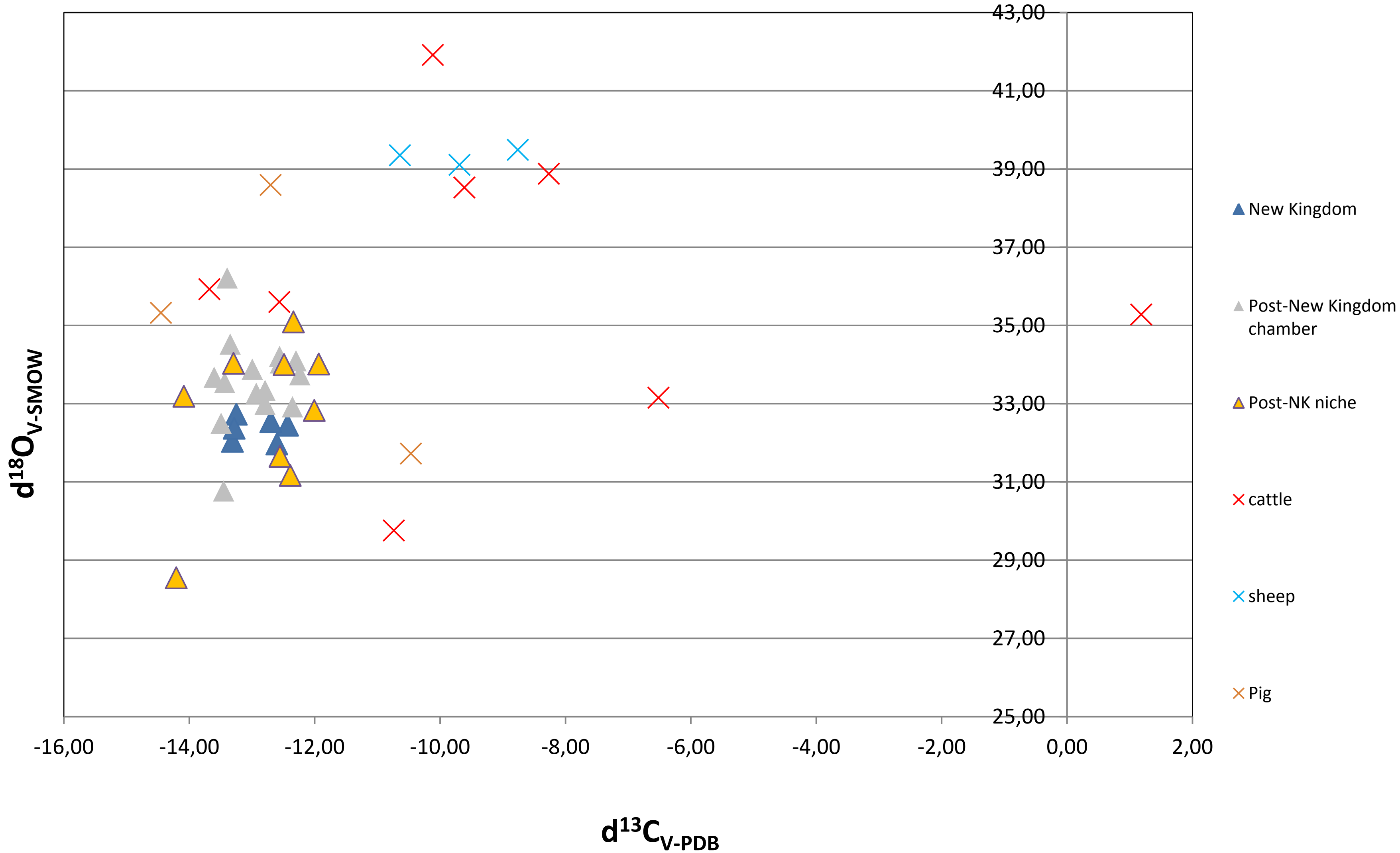

Figure 8.52: Carbon (x-axis) and oxygen (y-axis) isotope ratios of the human and animal samples from Amara West

8.13.3. FTIR

FTIR-spectra were obtained for all samples in order to test for contamination of carbonate. In all samples, the spectra conform to those expected for dental enamel (Weiner, 2010: 291). Contamination was not detected in any of the samples, therefore the results obtained from apatite carbonate can be assumed to be representative.

The results of the analysis of the indicators of physiological stress and disease used to address the research questions of this project, as well as of the analysis of stable isotope ratios, which were presented in this chapter are discussed with regards to their clinical significance and differential diagnosis, and will be set against the socio-cultural, historical, environmental, and archaeological background of the people living at Amara West.

Chapter 9. Discussion

This chapter discusses the results outlined in Chapter 8. in order to explore temporal trends in the observed markers of stress and disease. Set within the historical, environmental, cultural and archaeological context outlined in Chapter 2. and Chapter 3. the results are examined in order to consider whether the proposed hypothesis that changes in climate and political power had an impact on the population at Amara West can be supported. In order to set the individuals from Amara West into a wider regional context, the data are further compared to results from other relevant sites from Egypt and Sudan (see Figure 9.1, Table 9.1). A summary of data for each individual analysed in the thesis is presented in Appendix II.

9.1. Comparative data

As described above, in order to set the bioarchaeological data gained through the analysis of the individuals from Amara West into a wider regional context, the data are compared to published data from several ancient Egyptian and Sudanese sites with broadly similar chronological, geographical and/ or ecological backgrounds, even though it is recognised that at a site-specific level there may have been considerable variations in terms of habitat and subsistence patterns (see Table 9.1). Due to the fact that non-elite cemeteries are still rarely excavated in the region and to an even lesser degree analysed and published adequately, only a small number of sites provided reliable demographic and palaeopathological data. In addition to the Nubian sites discussed in this chapter, data from a few additional archaeological sites in Egypt and Sudan were also used for comparison. As these sites will repeatedly be cited in the following discussion, they are briefly introduced with regard to their chronological, social and economic background.

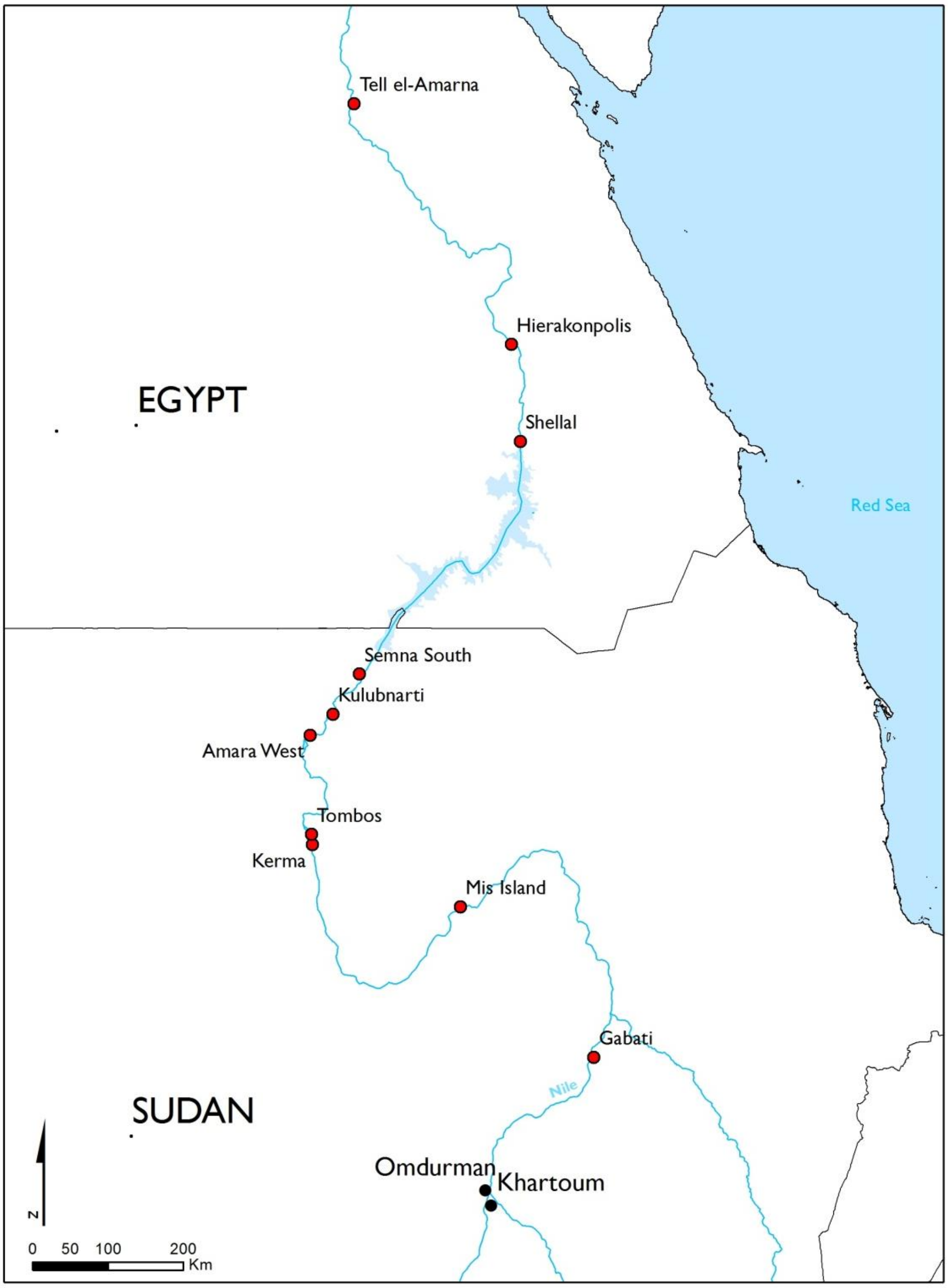

Figure 9.1 Archaeological sites in Egypt and Sudan used for comparison with the bioarchaeological data from Amara West (created by M. Binder)

9.1.1. Kerma

The data used for comparison in this study derive from the remains of a group of people from the town excavated by Reisner in the early 20th century (Reisner, 1923). Even though much about the nature of the settlement still remains to be learned, based on the scale and layout of the architectural remains uncovered at Kerma, it is assumed to represent an early urban community (Edwards, 2004: 83–84). A reliance on crops and livestock, most importantly cattle, also seems certain. The human remains are now part of the Duckworth Collection at the University of Cambridge. Analyses of these remains by Judd (2002, 2004) and Buzon (Buzon, 2006b, Buzon & Judd, 2008, Buzon & Bombak, 2010) contribute greatly to our present knowledge of the bioarchaeology of Sudan.

9.1.2. Tombos

The New Kingdom site at Tombos has already been described in more detail in Chapter 2. The New Kingdom and post-New Kingdom human remains (currently about 200 individuals, Buzon pers. comm, 2013) are currently curated at Purdue University, USA. Bioarchaeological analysis has been mainly carried out by Buzon and more recently by Schrader, including craniometric and isotope based studies of migration (Buzon, 2006a, Buzon *et al.*, 2007, Buzon & Simonetti, 2013), dental health (Buzon & Bombak, 2010), trauma (Buzon & Richman, 2007) and osteoarthritis (Schrader, 2012).

9.1.3. The Scandinavian Joint Expedition samples ("Pharaonic", C-Group, Shellal)

The skeletal human remains from Shellal (1500–1070BC) as well as the pooled multi-site samples summarised under the terms "Pharaonic" (1650–1300BC) and "C-Group" (2000–1600BC), were excavated during the Nubian High Dam campaigns in Lower Nubia in the 1960s by members of the Scandinavian Joint Expedition (Säve-Söderbergh & Troy, 1991a). Excavations were only carried out in the cemeteries, and therefore no corresponding settlement evidence exists for these samples. Nevertheless, the groups are very comparable in terms of their environmental context. The subsistence patterns of the C-group people are still under debate due to the lack of settlement data but it appears likely that they would have mainly been agriculturalists (Edwards, 2004: 94). For the New Kingdom samples a mainly agriculture-based lifestyle can also be assumed based on archaeological evidence from the wider region. The human remains are now permanently curated at the Biological Anthropology Laboratory, University of Copenhagen, Denmark and bioarchaeological data have been published by Vagn Nielsen (1970a) and later by Buzon (Buzon, 2006b, Buzon & Bombak, 2010)

9.1.4. Semna South

The large Meroitic necropolis at Semna South in the area of the 2nd Cataract was excavated by a team from the Oriental Institute in Chicago between 1966 and 1969 and prior to the heightening of the Aswan Dam (Žabkar & Žabkar, 1982). Roughly 560 graves and 592 individuals were recovered (Alvrus, 1999). Fieldwork mainly focused on the Middle Kingdom fortress, and a settlement associated with the Meroitic cemetery was not located. Based on the environmental, geographical and archaeological context, the population represents a small agricultural community in a settlement on the bank of the river in the narrow, rocky stretch of the Nile Valley in the 2nd Cataract area.

9.1.5. Gabati

Gabati, located north of Khartoum, was excavated in 1994 under the auspices of the Sudan Archaeological Research Society, directed by Edwards (1998). This multi-period cemetery was occupied in the Meroitic (200BC–300AD), post-Meroitic (400–600BC) and Christian periods (900–1100AD). The collection of 144 human remains was analysed and published by Judd (2012). Excavations were only carried out in the cemeteries, and an associated settlement could not be located. Therefore, little is known about the subsistence of the population even though it has been suggested that the people living at Gabati represented an agriculturally based, riverine community (Edwards, 2004: 150).

9.1.6. Kulubnarti

Even though the medieval site of Kulubnarti is of much later date than Amara West (550–1450AD), located in the harsh territory of the 2nd Cataract region only 45 kms downstream from Amara West, it was chosen as a comparative site due to the large amount of good quality bioarchaeological data. The two large cemeteries were excavated by Adams in 1979 and all skeletal material was transferred to the University of Boulder, Colorado. Based on the archaeological findings, the population was characterised as a non-elite, agricultural population (Van Gerven *et al.*, 1981). The large collection of 406 sub-adult and adult skeletal human remains represents the most extensively studied population in all of Nubia. Palaeopathological studies include the systematic analysis of general stress indicators (Van Gerven *et al.*, 1981), osteoarthritis (Kilgore, 1984), trauma (Kilgore *et al.*, 1997), and sinusitis prevalence (Roberts, 2007) and sub-adult growth (Hummert & Van Gerven, 1983).

9.1.7. Mis Island

Mis Island, now submerged under the lake building up behind the Merowe dam at the 4th Cataract in Sudan, was excavated for two seasons as part of the large-scale rescue surveys ahead of the construction of the dam between 2005 and 2007 (Ginns, 2007).

Amongst a number of sites from different time periods, a major focus of the archaeological activities has been two large Medieval cemeteries (3-J-10 and 3-J-11). With regard to their socio-economic background, the population was characterised as a simple, non-elite farming community. While a large part of the collection remains with the British Museum, a sample of 188 individuals was relocated to Michigan State University for research. Bioarchaeological data for this sample were recently made available through the PhD thesis of Hurst (2013).

9.1.8. Hierakonpolis

Human remains were excavated from two chronologically different cemeteries at the Upper Egyptian site of Hierakonpolis. The larger Pre-Dynastic cemetery (3800–3600) was excavated by Friedman between 1996 and 2004. Described as a working class population, 452 individuals were recovered (Gamza & Irish, 2012). The second cemetery dates to around 1750–1550BC and represents the burial ground of a migrant Nubian C-group population. In terms of subsistence, C-group people are usually characterised as agriculturalists or semi-nomadic cattle-herders. Grave goods suggest a relatively high socio-economic status for the people buried in the later cemetery (Friedman, 2007). The dentitions of both populations have been examined for evidence of dental pathologies by Irish (Irish, 2007, Gamza & Irish, 2012) and provide a useful comparative dataset for Amara West.

9.1.9. South Tombs Cemetery Tell el-Amarna

The South Tombs Cemetery at Tell el-Amarna represents a large area of non-elite cemeteries associated with Akhenaton's short-lived capital, which was only occupied for a short period of time between 1349 and 1332BC (Kemp *et al.*, 2012). Systematic excavations in the cemeteries have taken place since 2005 and led to the discovery of over 300 burials to date (Dabbs & Davis, 2013). Due to the wealth of archaeological and historical data, much is known about the material culture and life of the 20–30.000 people that are estimated to have lived at Amarna during the short time of its occupation (e.g. Kemp & Stevens, 2010b, a). Comprehensive skeletal analysis, including palaeopathological recording, was performed on site by Rose, co-workers and students. Key publications of the palaeopathological data include that of Kemp *et al.* (2012) as well as reports published on the project website[7]. However, in contrast to the other comparative sites cited in the text,

[7] http://www.amarnaproject.com/pages/recent_projects/excavation/south_tombs_cemetery/

publication of data lacks sufficient details about the methods employed to diagnose the pathological conditions. Therefore, comparability is limited.

Site	Country	Date	Number of individuals	Population characteristics	Bioarchaeological data	References
Kerma	Sudan	1750–1550BC	212	proto-urban, agricultural	dental pathology, trauma, periostitis	Judd, 2002 Judd, 2004 Buzon & Judd, 2008, Buzon & Bombak 2010
C-Group	Sudan	2000–1600BC	227	early agricultural	stature, dental pathology, periostitis	Buzon, 2006, Buzon & Bombak 2010
Shellal	Sudan	1500–1070BC	103	agricultural	stature, dental pathology	Buzon, 2006, Buzon & Bombak 2010
Tombos	Sudan	1500–1070BC	200	agricultural	mortality, stature, dental pathology, periostitis, trauma, osteoarthritis	Buzon, 2006, Buzon & Bombak 2010, Buzon & Richman, 2007, Schrader, 2012
"Pharaonic"	Sudan	1650–1350BC	65	agricultural	stature, dental pathology, periostitis,	Buzon, 2006, Buzon & Bombak 2010
Semna South	Sudan	200BC–1400AD	592	agricultural	trauma	Alvrus, 1999
Gabati	Sudan	200BC–1100AD	144	agricultural	stature, dental pathology, trauma	Judd, 2012
Kulubnarti	Sudan	550–1450AD	406	agricultural	growth profiles, trauma, osteoarthritis	Hummert & Van Gerven, 1983; Kilgore, 1984, Kilgore & Jurmain, 1997
Mis Island	Sudan	300–1400AD	188	agricultural	mortality, dental pathology, periostitis	Hurst, 2013
Hierakonpolis – Predynastic	Egypt	3800–3600BC	137	"workmen's cemetery" agricultural	dental pathology	Gamza & Irish, 2012
Hierakonpolis – C-group	Egypt	2055–1700BC	74	migrant population, agricultural/ semi-nomadic	dental pathology	Irish, 2007
Tell el-Amarna, South Tombs Cemetery	Egypt	1349–1332BC	300	"workmen's cemetery", agricultural	mortality, stature, dental pathology, trauma, osteoarthritis	Kemp et al. 2012, Dabbs & Davis, 2013

Table 9.1 Comparative samples cited in the text

9.2. Demography

9.2.1. The lack of infants at Amara West during the New Kingdom period

The apparent lack of sub-adults during the New Kingdom period is surprising, given that prior to the onset of modern medical care, mortality of infants and children can generally be assumed to have been high due to infectious diseases, malnutrition and poor hygiene (Lewis, 2007: 81–85). Therefore, one might expect to see high mortality for sub-adults throughout the whole time of occupation of Amara West. The absence however may be explained by differential treatment of infants and children in ancient Egyptian culture. Funerary customs for infants in ancient Egyptian culture were generally highly varied throughout the entire Pharaonic period (Verlinden, 2008, Zillhardt, 2009). Unfortunately, more systematic research is often hindered by the poor quality of excavations in the 19th and first half of the 20th centuries. Despite generally excellent preservation conditions in ancient Egyptian sites, the presence of children in the archaeological record of ancient Egyptian towns and cemeteries varies greatly depending on recovery strategies. Detailed age-specific analysis is further complicated by lack, or inadequate recording, of human remains, many of which are not available for study anymore because they were not curated. Particularly large variation exists with regard to place of burial, which appears to have been dependent on age-at-death and, to a lesser degree, social status (Meskell, 1994, Zillhardt, 2009: 40, 89). Children younger than 18 months were preferentially buried within settlements (David, 1986:112, Verlinden, 2008: 71, Zillhardt, 2009: 89). Examples dating to the New Kingdom period come from Elephantine (e.g. Kaiser *et al.*, 1993) as well as Nubian sites related to phases of Egyptian control such as at Askut (Smith, 1995, Britton, 2006). In the settlement of Amara West, infants have not been identified, to date. However, they also occur in cemeteries where people are buried in simple pits, or together with adults such as in the South Tombs Cemetery at Tell el-Amarna, or the 19th Dynasty cemetery at Tell el-Dab'a (Binder, unpublished data; Hulková, 2013). In the Deir el-Medineh's Eastern Necropolis, very young infants were all buried in a separate zone of the cemetery at the bottom of the hill (Meskell, 1994: 38, Zillhardt, 2009).

Past the first year of life, children were buried within the cemeteries but, again, there is considerable site-specific variation. The practice of using separate zones within cemeteries appears to be particularly common also for older children, even though there is not enough data to identify patterns or conventions regarding age limits. Examples contemporary to Amara West are the New Kingdom sites of Gurob (Brunton & Engelbach, 1927) and Deir el-Medineh (Zillhardt, 2009: 35). Similar practices appear to be a feature in more traditional Sudanese culture as well as being observed in the *Kerma classique* cemetery at nearby Sai (Murail *et al.*, 2004). At other sites, child burials are observed in simple single pits surrounding a pyramid or chamber (examples are Tombos, Smith, 2003: 156), within the shafts of chambered tombs, or within chambers together with the adult burials (Zillhardt, 2009: 88–89). In cemeteries dating to the 2nd Intermediate Period, pit burials of children have been observed in clusters rather than randomly distributed (Verlinden, 2008: 71–72). For example, at Tombos, a chamber only holding a large number of child burials was discovered in 2013, even though up until now it is unclear whether they date to the New Kingdom or post-New Kingdom period (Smith, Buzon, pers. comm.). Thus, due to this variety of funerary rituals observed in Egyptian and Nubian sites, the absence of children at Amara West so far is not surprising and may be related to the fact that they were buried in areas that have not been detected yet.

Related to this observation, in 2013, disarticulated remains of neonates and infants were uncovered in the disturbed fill near the entrance of the first western chamber of G244. However, a detailed examination of these remains is pending. The practice of placing infants exclusively in the entrance areas of chambers has also been observed in the Middle Kingdom tombs of Qubbet el-Hawa (Verlinden, 2008: 72). Just outside of the New Kingdom pyramid tomb (G112), north of the northern chapel wall in Cemetery D (excavated by the EES is 1939), the burial of an infant (2–3 years) was found in a shallow pit only 0.4m below the present surface. The infant was covered with the remnants of an organic container, which was perhaps a basket, even though due to heavy termite-frass it was difficult to establish the exact nature of the object. The lack of grave goods leaves the dating of the burial impossible. Moreover, the fact that, judging from the size of the burial pit itself, it appears to be made for an adult, and doubts remain as to whether this burial can be considered as primary or rather represents secondary re-use of an existing pit. However, the location of the burial would fit well with what is observed at Tombos (Smith, 2003: 156), and the practice of burying small children in basketry is well evidenced at Deir el-Medineh too (Meskell, 1994). In addition, this burial highlights another potential complication in recovering child burials at Amara West. The pit is very shallow and, while in Cemetery D the original surface surrounding the tombs seem at least partially intact, heavy surface deflation due to wind erosion is seen in Cemetery C. Therefore, if children were systematically buried in shallow pits, they may have simply disappeared from the archaeological record.

Alternatively, it may be argued that, particularly during the early phases of occupation of the town, it would have been populated by army personnel and administrators. However, excavations have failed to reveal substantial barrack quarters. The nature of the houses is similar to contemporary settlements in Egypt proper (Spencer, pers. comm, 2014), and therefore it remains unlikely that the absence of children in tombs dating to the New Kingdom period can be used as an argument against the presence of families at Amara West.

In contrast, child burials regularly occur in tombs of the post-New Kingdom period at Amara West (see Figure 9.2, Figure 9.3). They appear equally common within the chamber tombs, buried together with adults, as well as in single or multiple niche burials (see Table 9.2).

	Chamber tombs	**Niche burials**
Foetus	1	1
0–1 years	4	5
1–5 years	9	8
6–12 years	8	5

Table 9.2 Post-New Kingdom child burials according to grave type

Thus, rather than representing a sharp deterioration in living conditions, the sudden appearance of child burials in the post-New Kingdom more likely indicates significant cultural changes manifested in funerary rituals. This is consistent with later periods of Nubian history where infants and children occur regularly again within some cemeteries (e.g. Batrawi, 1935, Hummert & Van Gerven, 1983, Judd, 2012), even though other researchers still note an underrepresentation (Crubezy *et al.*, 1999).

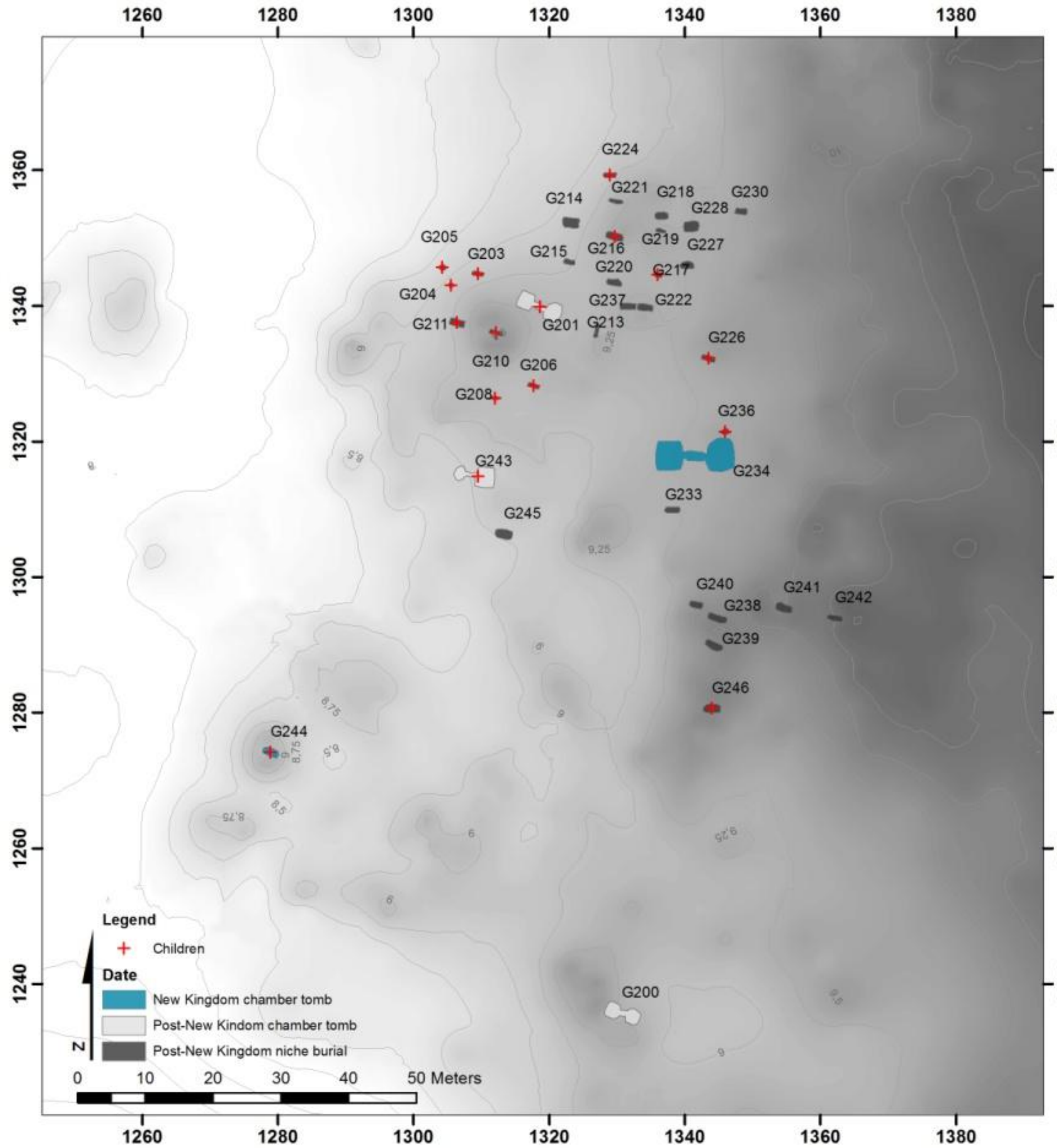

Figure 9.2 Spatial distribution of child burials in Cemetery C (created by M. Binder)

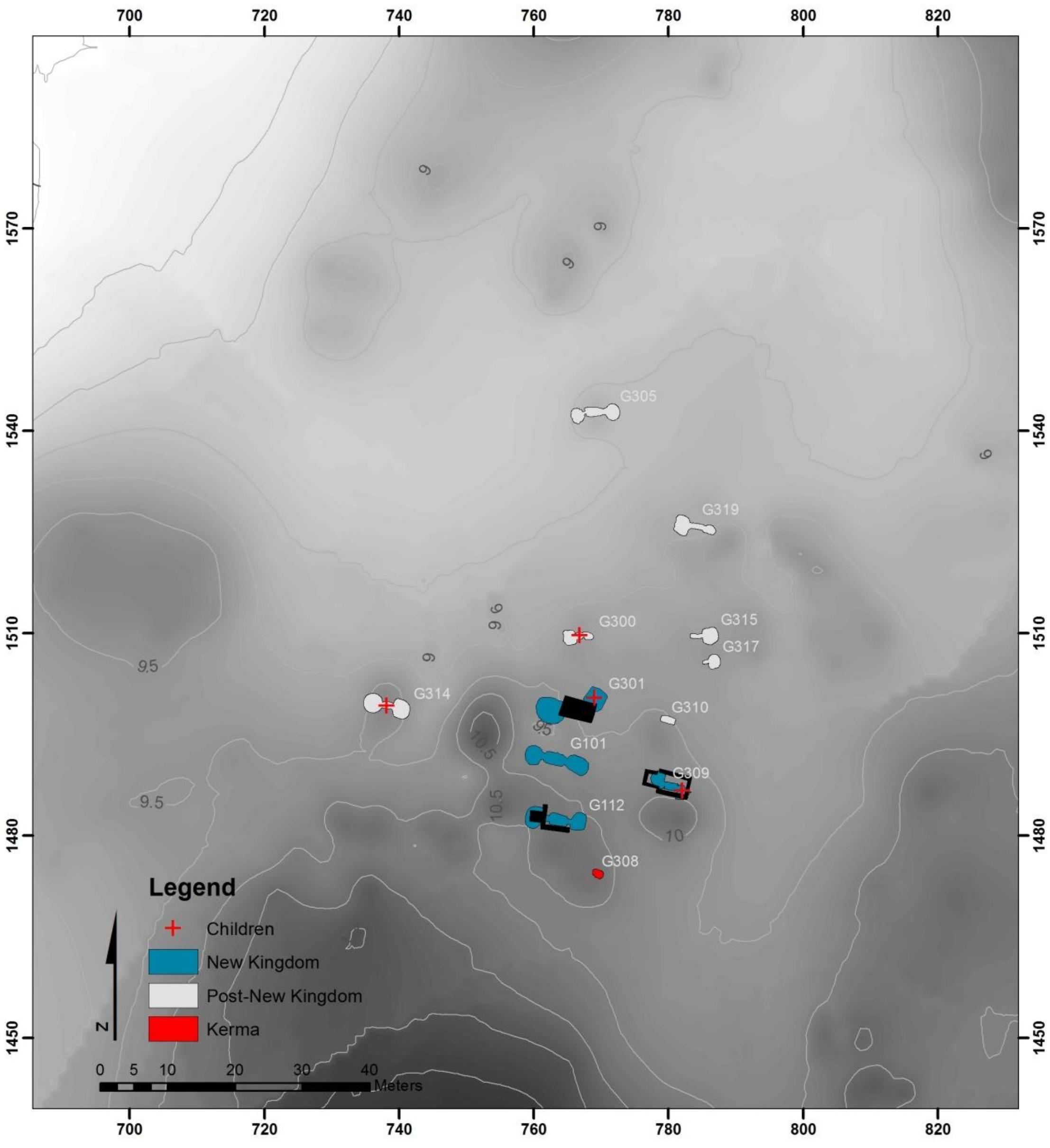

Figure 9.3 Distribution of children in Cemetery D (created by M. Binder)

9.2.2. Infant mortality during the post-New Kingdom period

Mortality of infants and children under five years of age is considered a main indicator of the quality of living conditions today (WHO, 2012). Countries with the highest rates are Chad, Afghanistan and the Republic of Congo with rates around 20%. The main reasons for child mortality worldwide are diarrhoeal diseases, pneumonia, malaria, neonatal sepsis, pre-term delivery and asphyxia at birth (Bryce *et al.*, 2005). At post-New Kingdom Amara West, infants and children under five years of age comprised 1.1% of the sample. Comparing this rate to other roughly contemporary sites elsewhere in the Nile Valley is difficult due to site-specific differences in funerary customs. This leads to a culturally induced underrepresentation of children such as at Tombos (Buzon, 2006b), but more commonly this is due to inadequate analysis of skeletal material. Differences in data collection and presentation further limit comparability. In the non-elite South Tombs cemetery at Tell el-Amarna, infants and children below seven years comprised 27% of the entire sample (Dabbs & Davis, 2013).

In modern Sudan, mortality of children under five is estimated at 8.3% (UNICEF, 2013). The main causes are pneumonia, diarrhoea and malaria, malnutrition, and contaminated food and drinking water. The country's natural and ecological profile permit the existence of a large spectrum of communicable disease, mainly infectious and parasitic diseases such as malaria, tuberculosis, schistosomiasis, visceral leishmaniasis and diarrhoeal infections and respiratory diseases (WHO, 2013a: 17). According to palaeopathological, biomolecular and historical data from ancient Egypt, all of these diseases have been present in the region since antiquity (Buikstra *et al.*, 1993, Zink *et al.*, 2003, Zink *et al.*, 2006, Nerlich *et al.*, 2008) and therefore may have contributed to the high levels of sub-adult mortality at post-New Kingdom Amara West.

The settlement of Amara West and its surrounding environment would have provided an ideal habitat for reservoirs for a large number of different diseases and disease-vectors, which could account for high levels of sub-adult mortality. Diarrhoeal infections can be caused by a host of viral, bacterial and parasitic agents. Transmission occurs through contaminated faeces, the main routes being either through contaminated water or food, or via hand-to-hand contamination between humans (Keusch *et al.*, 2006). Contamination of water during and after collection from the source has been identified as one of the major reasons for high levels of diarrhoeal diseases in developing countries (Gundry *et al.*, 2004). Water stands within the New Kingdom houses provide archaeological evidence that, in the ancient settlement, drinking water was consumed from storage containers rather than directly from the source. This would have further facilitated contamination of water through insects, animals and infected humans. There is an absence of intact settlement layers from the post-New Kingdom period at Amara West and therefore it is not known whether this practice was still in use, but it can still be observed in modern houses in Nubia as well as elsewhere in Northern Africa and the Middle East. Therefore, it seems likely that post-New Kingdom dwellers at Amara West would have stored their water in a similar way. Traditionally made of ceramic, these water storage containers (*zir,* see Figure 9.4) have been found to be one of the major sources of high levels of parasitic diarrhoeal diseases, and to a lesser degree infections with hook- and roundworms (*ascariasis*), in Egyptian and Nubian villages in Upper Egypt in a large-scale survey carried out in the 1970s (Miller *et al.*, 1980: 5–6).

Figure 9.4 Water storage in large *zirs* in the excavation house at Amara West (© M. Dalton)

Further possible environmental sources of disease identified within the settlements include ineffective drainage and disposal of human waste, which today traditionally takes place outside of houses and in the fields, as well as the keeping of animals within houses and settlements (Miller *et al.*, 1980: 42–43). Not only does the close proximity to animals facilitate the spread of zoonotic infections such as tuberculosis or brucellosis, but stable floors also provide ideal breeding habitats for black flies and sand flies responsible for the spread of fly-borne diseases such as visceral leishmaniasis or trachoma (Meade & Earickson, 2000: 61–63, Mascari *et al.*, 2013). Even though little is yet known about actual sanitation practices, or about the nature of the presence of animals within the settlements, research is ongoing and more information will be available in due course. Glimpses into hygiene within the town comprise the deposition of organic waste in street E13.12 and animal dung found in house D12.6, both would have been considerable reservoirs for disease vectors (Spencer, pers. comm. 2014).

Equally notable is the occurrence of older children in the post-New Kingdom period at Amara West. While mortality of children under five is well researched due to its pertaining relevance, relatively little modern data are available with regard to mortality rates for older children (Walker & Black, 2010). At Amara West as well as in other populations from archaeological sites, older children often make up almost as large a proportion of the entire sample as children below five. At Tell el-Amarna, 17%

of the sample is comprised of children between seven and 14 years (Dabbs & Davis, 2013), and in the 19th Dynasty non-elite cemetery of Tell el-Dab'a 21% of the sample was represented by children between six and 18 years (Binder, unpublished data). Similarly high values have been observed in pre- and proto-industrial cities of central Europe (Lewis, 2007: 82). Therefore, the overall proportion of sub-adults of all age categories in the post-New Kingdom sample can be interpreted as an indication of significant disease burden affecting the post-New Kingdom inhabitants of the Amara West area. These observations correspond well with a recent review of epidemiological data from developing countries in Africa and Asia, which has shown that morbidity and mortality due to diarrhoeal and gastrointestinal diseases in older children declines far less than previously thought and remains relatively high well into adolescence (Walker & Black, 2010). In Sudan, aside from diarrhoeal diseases, the most prevalent of the parasitic diseases, and one of the country's major sources of morbidity and mortality amongst children as well as adults, is schistosomiasis (WHO, 2013a). The disease is transmitted to humans from freshwater snails, via the larvae of the parasite being released by the snails into bodies of water (Eddleston *et al.*, 2008: 314–317). Standing water bodies such as irrigation channels (see Figure 9.5) are the preferred habitats for these disease vectors. Most at risk are groups habitually involved in activities involving close proximity to water, and first and foremost agricultural and fishing populations (Ahmed, 2013b) Children are considered to be particularly vulnerable due to playing near or in such water bodies and because of poor hygiene. According to modern epidemiological data from regions where Schistosomiasis is prevalent those most affected are children in the age group between 10 and 19 years of age (Ahmed, 2013b).

Whether schistosomiasis was present at ancient Amara West is not yet established. Attempts to identify parasite eggs in soil samples taken from the pelvic region of two New Kingdom and two post-New Kingdom individuals have failed to provide any conclusive evidence for schistosomiasis or any other parasitic diseases. However, it is hoped that future research in this direction, including the analysis of further soil samples or application of immunobiological methods on tissue samples may help to shed further light on the presence of schistosomiasis as well as other gastro-intestinal parasites at Amara West.

Figure 9.5 Irrigation channel at Ernetta Island

Despite the absence of direct evidence from Amara West, the disease's long history in the Nile Valley region is well evidenced. Adult schistosomes were first identified in an Egyptian mummy (1250–1000BC) by Ruffer (1910). The presence of antigens in the tissue of Pre-Dynastic mummified human remains further suggests the disease has been a major health problem in Egypt since around 3200BC (Deelder *et al.*, 1990). In Sudan, evidence of schistosomiasis in the form of parasite eggs has been reported in human remains from Sai (c. 1500BC) (Bouchet *et al.*, 2003), even though the publication is somewhat obscure and does not provide conclusive evidence to confirm this diagnosis. Around 350–550AD, the disease was prevalent in the Wadi Halfa area north of Amara West (Hibbs *et al.*, 2011). Whether schistosomiasis is described in ancient Egyptian medical texts is still under debate (Nunn, 1996). However, despite the theoretical possibility of its presence, in the light of climatic deterioration it remains questionable as to what point environmental conditions would have been suitable to sustain freshwater snails transmitting schistosomiasis. The disease's prevalence is generally low in the Northern Sudanese Nile Valley today due to the low amount of standing water and irrigation schemes (Jobin, 1999: 308) Nevertheless, recurring outbreaks in irrigated areas of the Dongola Reach, Wadi Halfa and along the shores of Lake Aswan were reported throughout the 20th century (Archibald, 1923, Miller *et al.*, 1980). Therefore, as long as intermittent flooding allowed permanent water reservoirs at Amara West, schistosomiasis may well have been a common health problem there too and would provide a reasonable explanation for the high mortality seen amongst children.

9.2.3. Mortality of the adult individuals

Mortality rates for adult individuals were similar both during the New Kingdom and post-New Kingdom periods and do not indicate any major changes to the demographic structure of the sample. During both time periods, young adults (21–35 years) represent the largest group, making up for more than half of the sample (New Kingdom: 56,0%, Post-New Kingdom: 53,4%). A low life expectancy and high mortality rates in young and middle adult individuals are a general characteristic of pre-modern societies worldwide and can mainly be attributed to infectious diseases, and to a lesser degree malnutrition and conflict (Omran, 1971, McKeown, 2009).

As has already been outlined above (see section 9.2), the ecology of the Sudanese Nile Valley provides a suitable habitat for a wide spectrum of infectious diseases, including malaria, schistosomiasis, visceral leishmaniasis, tuberculosis and a host of different gastrointestinal diseases leading the field in terms of morbidity and mortality in modern Sudan today (WHO, 2013a). Even though none of these diseases would leave unambiguous, macroscopic changes in the skeleton in the majority of cases, textual (Nunn, 1996), palaeoparasitological (e.g. Deelder *et al.*, 1990, Miller *et al.*, 1992) and biomolecular evidence (e.g. Miller *et al.*, 1994, Zink *et al.*, 2003) suggest that all of them have been present in Egypt, and potentially Sudan, since antiquity and therefore would have likely affected the adult individuals at Amara West too.

In diachronic comparison, the demographic structure is remarkably similar in both time periods and consequently does not indicate any dramatic changes in living conditions. More pronounced differences were observed when analysing male and female individuals separately. In the New Kingdom women, a slight rise in young-adult mortality was observed, while the proportion of men in this age category is similar. In contrast, more women lived into the middle adult category during the post-New Kingdom period, whereas the reverse trend was observed in male individuals. However, the sample sizes are very small and therefore not necessarily representative for the entire population.

Old adult individuals were generally relatively rare, even though the proportion is somewhat higher during the post-New Kingdom (12%), than during the New Kingdom (8%) period. The invisibility of old individuals in the archaeological record due to inaccurate ageing methods is a well documented problem in bioarchaeological research (outlined in Section 8.7). Textual evidence from contemporary non-elite cemeteries such as Deir el-Medineh in Upper Egypt suggests that it was certainly possible to live into the 6th and 7th decade of life (Gabler, 2009). Nevertheless, at Amara West those individuals that could be aged all fall well into the young and middle adult ranges. Even though a small percentage could not be aged due to a lack of preserved age indicators, it appears unlikely that these only represent old adults and would change the demographic structure significantly. Thus, the low percentage of old adult individuals when compared to individuals under 50 does seems to suggest that this was because of living conditions at Amara West. The findings are consistent with data from other sites comparable both in terms of date range, geographical setting and socio-economic context. In the South Tombs cemetery at Amarna, only 2% of the individuals could be aged over 50 years (Dabbs & Davis, 2013). At Tombos or Kerma, on the other hand, individuals over 45 years constituted 16.5% and 20.1% of the adult population, respectively (Buzon, 2006b). Due to a high disease burden, a very low percentage of old individuals is still seen in the largely agricultural population of present-day Sudan, with only 6% of the total population being older than 55 (CIA, 2013). Therefore, the low percentage of old adults in both New Kingdom and post-New Kingdom samples is not an unusual finding. Whether the increase in older adults during the post-New Kingdom period is significant and indicates improved living conditions, enabling people to live longer, or whether this is an artefact of the small sample size, remains unclear. Studies in developing countries today and archaeological populations also often report lower ages-at-death in female individuals associated with complications during or after birth. However, no such trends could be observed in the Amara West sample where, in fact, during both time periods more men died under 35 than women.

9.3. Adult stature and growth

9.3.1. Adult stature and mean femur lengths

Adult stature reflects a complex interaction of genetic potential and childhood health and nutrition, and it is therefore generally considered a good marker of health and disease during growth of the skeleton in past human populations (Steckel, 1995, Larsen, 1997: 13–19). One of the main limiting factors for this strand of analysis in the groups from Amara West was the fragmentary nature of the sample. Only a small number of individuals featured one or more intact long bone that could be used for stature calculations. In New Kingdom females, stature could only be calculated for one individual. Thus, the resulting height difference between females in the two temporal samples is by no means significant. In males, the sample size in the New Kingdom group was only slightly better (three individuals). No differences were observed between the two male groups, with both achieving a mean height of 163.3cms. Comparison of stature data to other populations from archaeological contexts is difficult due to the multitude of estimation methods available and the lack of use of one method by all researchers However, Table 9.3 shows that the height of individuals from Amara West are very similar to those from other Sudanese and Egyptian sites, and only are the Gabati Meroitic females taller (Judd, 2012). The Amarna population has been described as one of the shortest in comparison to other Egyptian, sites which has been interpreted as a sign of severe growth disruption due to malnutrition and disease in childhood (Kemp *et al.*, 2012). The people from Amara West are very similar in height, even though stature was calculated using the method developed by Trotter & Gleser (1952). The same holds true for the individuals recovered from Sai (Murail, 2012). Thus, the values are not directly comparable. More revealing is the comparison with modern population data from the Nile Valley region. The only available data set for Sudanese populations was derived from an anthropometric study conducted on healthy, Sudanese Arabs in Khartoum (Ahmed, 2013a). Both females and males are markedly taller than the groups from Amara West.

Site	Date	Females	Males
Amara West NK	**1300–1070BC**	158.6	163.3
Amara West post-NK	**1070–800BC**	155.9	163.3
Sai[1,a]	**1500–1300BC**	155.5	163.5
Amarna[3,a]	**1349–1332BC**	154.02	163.75
Gabati[2,b]	**200BC–1100AD**	161.18	163.13
Sudanese Arabs[4]	**Modern**	160.26	175.11
Egyptians[4]	**Modern**	158.9	172.8

Table 9.3 Comparison of stature estimates from Amara West and other sites in Egypt and Sudan (data in cms, sources: [1]Murail, 2012, [2]Judd, 2012: 67, [3]Kemp et al. 2012, [4]Ahmed, 2013; stature estimation methods: [a]Raxter et al. 2008, [b]Trotter & Gleser 1952)

The stature data from Amara West could therefore potentially indicate significant growth disturbances caused by disease and malnutrition during childhood. In combination with the results from palaeopathological analysis discussed in more detail throughout the course of this chapter, this certainly represents a plausible option. However, an alternative explanation may be explained by underlying genetic reasons and the people living in the area (Amara West and Sai Island) may simply be part of a very short population. Modern Sudanese populations are on average relatively tall even though the sample is likely biased socio-economically and comprises people of a very different ethnic background. Unfortunately, nothing is known about the ethnic background of the ancient inhabitants from Amara West, and comparative data sets from archaeological populations to support or reject this theory are confined to the individuals from Sai. In addition, comparative data from modern Nubia which may provide further insights are not available.

A more comprehensive comparative data set, independent of methodological errors, is available for mean femur lengths. Due to the problems associated with available stature estimation methods available, mean femur lengths are now widely used as a good proxy for stature (Goodman & Martin, 2002). The New Kingdom sample is characterised by a high degree of fragmentation, and therefore no adult femurs were complete enough to be included in this strand of analysis. More data were available for the post-New Kingdom sample which could be compared to published data from other New Kingdom or Nubian sites for further discussion (see Figure 9.6 and Table 9.4). Both women and men rank at the lower end of the scale when compared to other samples.

With an average femur length of 41.3cm, only female individuals from Lower Nubian New Kingdom sites with an average length of 40.2cms (Batrawi, 1935: 189) were smaller than the female individuals from Amara West. Male individuals in contrast rank more in the medium range, with extremes represented by the Kerma (46.35cms) and Lower Nubian males (43.2cm). This comparison indicates a general temporal trend towards a decline in stature in the New Kingdom and post-New Kingdom periods throughout the Middle Nile Valley. However, whether this can be interpreted as a consequence of a generalised deterioration in climatic conditions remains unclear. The comparative samples are too diverse in terms of environmental and socioeconomic background, settlement and subsistence patterns to allow for any meaningful inferences about wider trends. While the New Kingdom samples (Tombos, New Kindom_1 and New Kingdom_2 and Amara West) all represent urban populations from more marginal areas. Considerable differences in the ethnic backgrounds of the comparative samples may have introduced additional bias, and differences in stature may also at least partially be explained by hereditary factors rather than exposure to physiological stress during childhood.

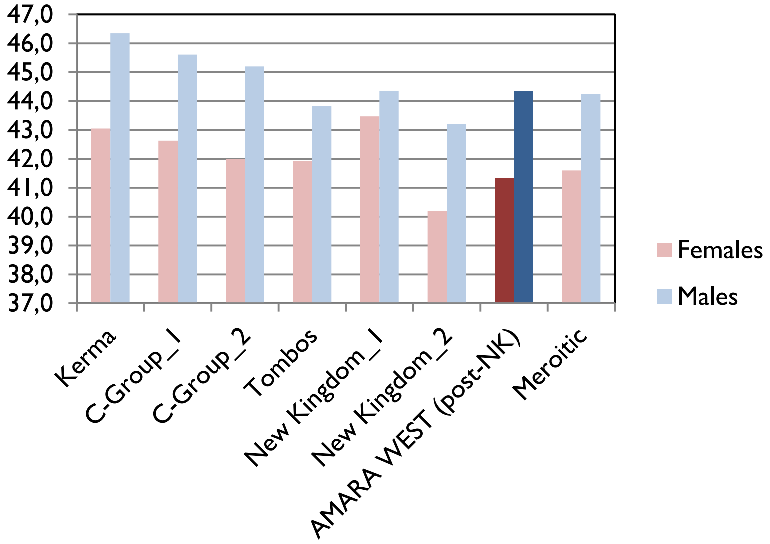

Figure 9.6 Comparison of post-New Kingdom Amara West femur lengths to other sites in Sudan (data in cm)

	Kerma	C-Group_1	C-Group_2	Tombos	New Kingdom_1	New Kingdom_2	AMARA WEST (post-NK)	Meroitic
Females	43.05	42.63	42	41.93	43.47	40.2	**41.3**	41.6
Males	46.35	45.61	45.2	43.82	44.36	43.2	**44.4**	44.25

Table 9.4 Comparison of post-New Kingdom Amara West femur lengths (data in cm) to other Sudanese skeletal samples (New Kingdom_2, C-Group_2, Meroitic: Batrawi, 1935; Kerma, Tombos, New Kingdom_1, C-Group_1: , Buzon, 2006b)

9.3.2. Growth profile

Growth profiles, comparing developmental stages of teeth and long bones in children have become an established way of assessing sub-adult stress (e.g. Saunders & Hoppa, 1993, Larsen, 1997: 9, Goodman & Martin, 2002: 21). A similar analysis was attempted for the individuals at Amara West. However, due to the generally small number of sub-adult individuals recovered, aggravated by the fact that they were mainly found in disturbed contexts and consequently often incomplete, the number of individuals that could be studied was very small and therefore the results are only of limited significance.

The data from Amara West were compared to modern growth standards for femur length as well as archaeological data from two other sites in Sudan (Kulubnarti, Wadi Halfa). In contrast to modern reference data, the children from Amara West appear relatively shorter than modern children. These standards were developed by Maresh based on radiographic assessment of healthy, well-nourished American middle-class children and are widely applied in bioarchaeological studies since they are the only modern comparative data set which includes femur length (e.g. Hoppa, 1992, Saunders & Hoppa, 1993, Hoppa, 2000, Dabbs & Davis, 2013). In a recent study (Schillaci *et al.*, 2012), the original data of Maresh were statistically compared to the more geographically and ethnically diverse standards of the WHO (2014) which serve as the main indicator of how a child free of disease should grow in modern growth studies. The researchers could confirm that Maresh's data indeed reflect normal healthy growth patterns and therefore can serve as a valid reference in terms of the growth process. However, Schillaci and co-workers also strongly warned against inferring stunting of growth in populations from different ethnic origins because of genetic differences which are still too poorly understood and because appropriate reference data sets currently unavailable (Schillaci *et al.*, 2012). Despite the small sample size, the comparison of the Amara West children indicates significant differences in long bone development when compared to modern healthy, normally growing children. In combination with other lines of palaeopathological evidence, growth disturbances due to disease and malnutrition are certainly reasonable to assume. Nevertheless, ethnic differences could have also, at least partially, contributed to the observed. No adequate modern reference data exist for Sudanese or Northern African populations, and therefore estimating the extent of genetic factors remains impossible.

When plotting the results from Amara West against data from two other sites in Sudan, it shows that the sub-adults from Amara West are consistently taller than the comparative samples. Explaining these differences has to remain tentative given the very small data set from Amara West. The sub-adult population at Kulubnarti was characterised as subject to a high degree of environmental pressure based on high sub-adult mortality, levels of cribra orbitalia and dental enamel hypoplasia (Hummert & Van Gerven, 1983). The pre-historic population at Wadi Halfa had values more similar to those at Amara West but are still somewhat shorter. When comparing other lines of evidence, cribra orbitalia rates at Kulubnarti (Mittler & Van Gerven, 1994) were relatively similar to Amara West. Major differences were observed in the prevalence of dental enamel hypoplasias, which were extremely high at Kulubnarti and affected all the population (Van Gerven *et al.*, 1990). This indicates significantly higher levels of physical stress during growth and may at least partially account for the observed differences in long bone length.

9.4. Dental Disease

9.4.1. Dental Attrition

The degree of dental attrition is a major predisposing factor for the development of dental diseases and therefore its extent was examined in the population from Amara West. The results of the analysis show a generally high degree of wear for both chronological subsamples. As tooth wear is a progressive process, increasing with age, values were also observed for each age group seperately. High levels of attrition were already occurring in young adults both during the New Kingdom and post-New Kingdom period, strongly indicating a highly abrasive diet throughout the time period of use of the site. An interesting observation was that for some teeth the mean attrition values in middle adult individuals did not differ significantly from young adults, which is most likely explained by the high degree of antemortem tooth loss often resulting in loss of corresponding lower or upper teeth to grind against.

Archaeological populations from the Nile Valley Region have generally been characterised by a high degree of dental wear throughout history (e.g. Smith, 1984, Buzon & Bombak, 2010, Gamza & Irish, 2012). The group from Amara West is no exception to this rule and values fall well within the range of observed attrition scores in other Egyptian and Sudanese sites. The high degree of attrition has mainly been attributed to a high content of grit in flour resulting from grinding cereals with grinding stones, as well as the accidental inclusion of windblown sand in the diet (e.g. Leek, 1972, Smith, 1984, Buzon & Bombak, 2010). Relevant to this observation, Leek (1972) examined several samples of desiccated ancient Egyptian bread from tomb contexts both through plain film radiography and petrographic analysis. This study revealed a remarkable degree of windblown sand, together with small angular grit fragments, which he interpreted as representing both chips from grinding stones as well as remnants of stones added to the grain deliberately to facilitate processing. These factors appear to be reasonable explanations for the individuals from Amara West. Even though no remains of bread have been discovered yet, cylindrical ceramic

Figure 9.7 Grinding stone F4006 from the settlement of Amara West

ovens assumed to have been used for bread, evidence of hulled and threshed cereals (Ryan *et al.* 2012) and numerous examples of grinding stones carved from schist, granite or sandstone (see Figure 9.7) are found all over the site. Many examples are heavily worn., perhaps with differential wear patterns allowing designation of some grindstones as cereal grinding stones, and thus they would have left traces within the resulting flour similar to those discovered by Leek. Contamination of the food with windblown sand, particularly on windy days is commonly experienced in the Amara West area. In light of the palaeoenvironmental and archaeological data from within the town providing evidence that sand and dust storms started to become a significant environmental problem during the time of occupation of the site, sand in the food would have certainly represented a major nuisance for the people at ancient Amara West too (Spencer *et al.*, 2012, Dalton, Forthcoming).

Diachronic comparison of the data does not show any major systematic shifts or patterns in the degree of attrition between the New Kingdom and post-New Kingdom dentitions. Even though some differences were observed in individual teeth, overall there appears to be a minor increase in the degree of dental attrition in the post-New Kingdom population. This finding would be consistent with increasingly arid conditions and consequent exposure to windblown sand. However, New Kingdom sample sizes for individual teeth are relatively small, and therefore any observed changes may also be an artefact of the low number of available teeth for analysis.

9.4.2. Caries

Rates of dental caries were relatively high in both groups from Amara West. This becomes particularly evident in comparison to other Nile Valley populations, and stands in contrast to observations by the majority of researchers who consistently have found relatively low frequencies of dental caries (Leek, 1972, Rose *et al.*, 1993, Beckett & Lovell, 1994, Buzon & Bombak, 2010). The low number of caries detected in ancient Egyptian populations is usually explained by the high degree of attrition which is thought to prevent adhesion of cariogenic bacteria to tooth surfaces (Greene, 1972).

However, this negative correlation in not universally true, as demonstrated by other studies which have found reverse trends in archaeological human remains (Burns, 1979). Higher caries frequencies only start occurring in ancient Egypt and Nubia in later time periods from the 1st millennium AD onwards, interpreted as a reflection of changes in dietary habits and subsistence strategies (Beck & Greene, 1989, Rose *et al.*, 1993).

However, despite these overall tendencies, caries frequency rates at Amara West represent the highest values observed in any of the comparative samples. Carious lesions were already present in deciduous teeth, indicating that the living conditions, and particularly diet, at Amara West held risk factors that exposed people to caries. Prevalence was found to be consistently high in both chronological samples. Only when controlled for by age, does a significant increase both in tooth-based and individual-based prevalence became evident in the young adult age group. Even though the New Kingdom group was relatively small in relationship to the post-New Kingdom group, the large difference cannot simply be explained by differences in sample size. In middle adults, caries rates are relatively similar. Caries is a progressive process (Hillson, 1996: 269), and therefore its prevalence is expected to increase with age. Consequently, prevalence in young adults serves as a better marker of actual caries burden and risk exposure within a population than in older age groups. Thus, the sharp increase in post-New Kingdom individuals could be interpreted as in indication of significant changes in exposure to factors causing caries in the people living at Amara West at this time.

Dental caries results from the focal demineralisation of dental enamel caused by organic acids produced during fermentation of carbohydrates by bacteria native to the oral flora in plaque (Hillson, 2005: 290–291) Thus, the main driving factor for caries formation is a diet rich in carbohydrates, most importantly sugar and starch, even though the role of the latter in caries formation is still under debate (Lingström *et al.*, 2000). The composition of the diet of Amara West's inhabitants during the New Kingdom period can be fairly well reconstructed based on archaeological and archaeobotanical findings. Sugar would have been readily available through the consumption of fruits of the doum palm, a species of palm tree native to the Nile Valley. These fruits have been shown to be very high in sucrose (Farag & Paré, 2013) Findings of charred doum fruits from occupation deposits in several phases in the town provide evidence that they were indeed part of the diet of the inhabitants of Amara West at least throughout the entire New Kingdom (Ryan *et al.*, 2012).

The main sources of starch in the diet can be found in cereals. Even though it remains unclear as to what extent they are responsible for the formation of caries (Lingström *et al.*, 2000), a daily diet heavily reliant on cereal based products can certainly be assumed for the people living at Amara West. Both archaeobotanical and isotopic data indicate that the main cereals consumed by both New Kingdom and post-New Kingdom people were emmer wheat and barley (Ryan *et al.*, 2012). These would presumably have been mainly been consumed in the form of bread or stews.

The sharp increase in caries prevalence in young adults of the post-New Kingdom period could be a reflection of changes in dietary habits in the later period, but in the absence of settlement evidence dating to the later period speculating about the nature and reasons of any such changes remain difficult. A large-scale agricultural survey carried out in Eritrea in 1996 (Connelly & Wilson, 1996: 56–57) has shown that doum palms are of particular importance as a source of food in years of bad harvests because the tree is relatively resistant to drought (see Figure 9.8), in contrast to other agricultural products. In times of hunger, doum palms become one of the major staples in these areas. Based on the archaeological and environmental data from the site, supported by isotopic evidence, it seems possible that if climatic deterioration decreased agricultural productivity to a degree that food became scarce during certain periods, people may have increasingly relied on doum palm fruits which could have consequently increased the levels of caries seen in the population.

Figure 9.8 Doum palms growing in the desert near Amara West (© P. Ryan)

Diet is not the only risk factor leading to caries formation. Other important parameters include general physiological status, genetic predisposition but also the geochemical composition of the ingested water (reviewed by Larsen, 1997: 65). Poor nutritional status, disease and psychological stress can all have a negative impact on an individual's immune response and will ultimately also increase the risk of developing carious lesions. Therefore, the observed changes could also at least partially reflect a higher degree of environmental stress acting upon the population, increasing susceptibility to caries. Moreover, if any dietary changes related to food shortage occurred, the effects would have likely been severely aggravated by additional physiological stress.

The comparison between caries frequencies for male and female individuals only revealed minor differences in the post-New Kingdom group and no differences in the New Kingdom people, even though the latter sample is very small and might therefore not be entirely representative. Some bioarchaeological (Larsen, 1997: 72–76) and recent clinical studies (Lukacs & Largaespada, 2006, Lukacs, 2011) have shown that caries prevalence is often higher in women which is attributed to hormonal, physiological or genetic differences as well as socio-cultural factors, such as differential access to food sources. At Amara West, the results do not indicate that similar practices were in place but rather show an equal degree of exposure to caries risk factors in both women and men.

The differences in caries rates when compared to other archaeological populations are also striking (see Figure 9.9 and Table 9.5), particularly given that the demographic profile of the Amara West groups contain relatively more young individuals than middle and old adult individuals. However, the samples are also biased with regard to sample size, and there appears to be a clear trend towards higher caries frequencies in small samples. Nevertheless, the differences are considerable and therefore might indeed be a reflection of differential exposure to caries risk factors. In terms of subsistence, all comparative groups represent agriculturalists with a diet heavily based on cereal consumption similar to the people at Amara West (Beckett & Lovell, 1994, Buzon & Bombak, 2010, Gamza & Irish, 2012). Whether these people equally consumed doum palm fruits remains unknown, but from an ecological point of view, all groups could have theoretically had access to palms as the tree is frequently seen all over Sudan and was native to Egypt once. Thus, it remains questionable whether the observed discrepancy can be explained by dietary factors alone. Differences in living conditions and socioeconomic status could also explain these differences. Other data (palaeopathological, historic and environmental) do not support the idea that living conditions at Amara West were significantly worse than elsewhere in the Nile Valley. Nevertheless, for none of the sites are the data sound enough to fully infer quality of life, and information about factors such as malnutrition remain relatively hidden. Therefore, frailty and subsequent susceptibility to caries could be another factor explaining both the diachronic differences in addition to those observed between Amara West and other sites. Differences in the chemical composition of water, specifically in fluoride content which is known to prevent caries formation (Hillson, 2001), can be excluded as a reason for the observed differences in caries prevalence. Hydrochemical studies of Nile water in Egypt have shown generally low levels of fluoride in water (Ahmed, 2014).

Oral hygiene and care is another parameter influencing the degree of caries as well as all other types of dental disease. Even though the dental profession has been tentatively identified in ancient Egyptian texts, archaeological evidence in the form of dental tools have not been found to date, and even if some form of dentistry was practiced it would have been reserved for the higher social classes (Leek, 1967). Evidence for the treatment of dental disease is confined to a small number of descriptions of remedies mentioned in the Papyrus Ebers (Nunn, 1996: 205). No other signs of dental care such as tools for cleaning of the teeth have ever been found in an ancient Egyptian archaeological context, despite excellent preservation conditions even for organic materials (Forshaw, 2009). Therefore one may speculate that the high levels of dental pathologies at Amara West and elsewhere in ancient Egyptian and Nubian sites are also a reflection of the complete absence of any form of dental care (Forshaw, 2009).

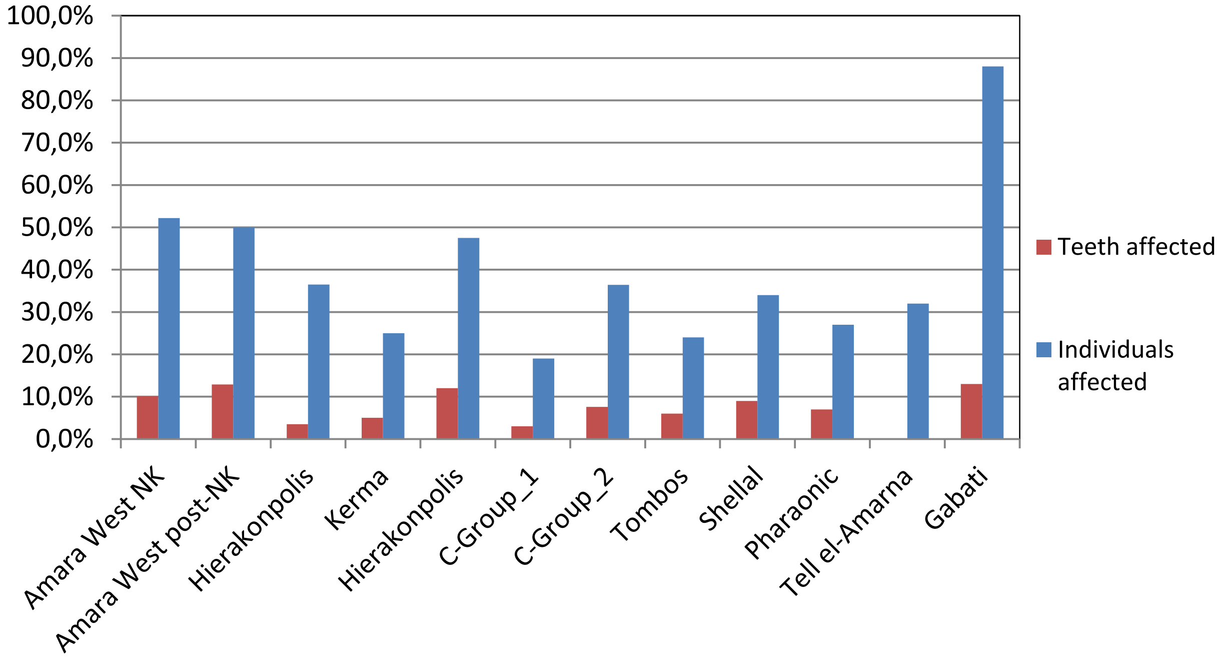

Figure 9.9 Caries prevalence rates at Amara West and other selected sites from Egypt and Sudan (teeth/individuals affected compared to teeth/individuals preserved, see Table 9.5)

Site	Date	Teeth affected			Individuals		
		n	N	%	n	N	%
Amara West NK	**1300–1070BC**	21	207	10,1	12	23	52,2
Amara West post-NK	**1070–800BC**	95	734	12,9	35	70	50,0
Hierakonpolis[1]	**3800–3600BC**	90	2604	3,5	50	137	36,5
Kerma[2]	**1750–1550BC**	103	1891	5,0	60	243	25,0
Hierakonpolis[3]	**2055–1700BC**	53	441	12,0	19	40	47,5
C-Group[2]	**2000–1600BC**	72	2156	3,0	44	227	19,0
C-Group[4]	**2000–1550BC**	28	367	7,6	12	38	36,4
Tombos[2]	**1400–1070BC**	53	821	6,0	18	76	24,0
Shellal[2]	**1500–1070BC**	41	474	9,0	29	86	34,0
Pharaonic[2]	**1650–1350BC**	35	472	7,0	19	70	27,0
Tell el-Amarna[5]	**1349–1332BC**	-	-	-	21	65	32,0
Gabati[6]	**200BC–1100AD**	8	619	1,3	8	91	8,8

Table 9.5 Caries prevalence at Amara West and other selected archaeological populations from Sudan and Egypt (n=number of affected, N=total number observed; sources: [1]Gamza & Irish, 2006; [2]Buzon & Bombak, 2010, [3]Irish, 2007; [4]Beckett & Lovell, 1994, [5]Rose & Zabecki, 2010; [6]Judd, 2012: 67)

9.4.3. Periapical lesions

Similar to caries frequencies, the number of periapical lesions was remarkably high in both groups from Amara West. High prevalence rates of theses lesions are another common feature of generally poor dental health in archaeological populations from the Nile Valley and have been reported in all analyses of skeletal human remains since Ruffer's studies in the 1920s (1920, Rose *et al.*, 1993, Buzon & Bombak, 2010). In comparison to published data from other sites (see Figure 9.10 and Table 9.6), both groups from Amara West fall well within the range of values common for Nile Valley populations.

Periapical lesions develop as a consequence of exposure of the pulp cavity because they allow bacteria to enter the root canal and consequently cause infection at the apex of the root (Hillson, 1996: 285–286). As a consequence, the frequency of this type of dental pathology is highly correlated with carious lesions as well as the degree of attrition (Lukacs, 1989). As has already been outlined above, both parameters show an exceedingly high prevalence in the Amara West groups, and therefore the high number of periapical lesions observed in the individuals comes as no surprise. Dental attrition remains consistently high throughout the time period of occupation of Amara West, but the increase in periapical lesions correlates well with the significantly higher caries prevalence in the later group when compared to their New Kingdom peers.

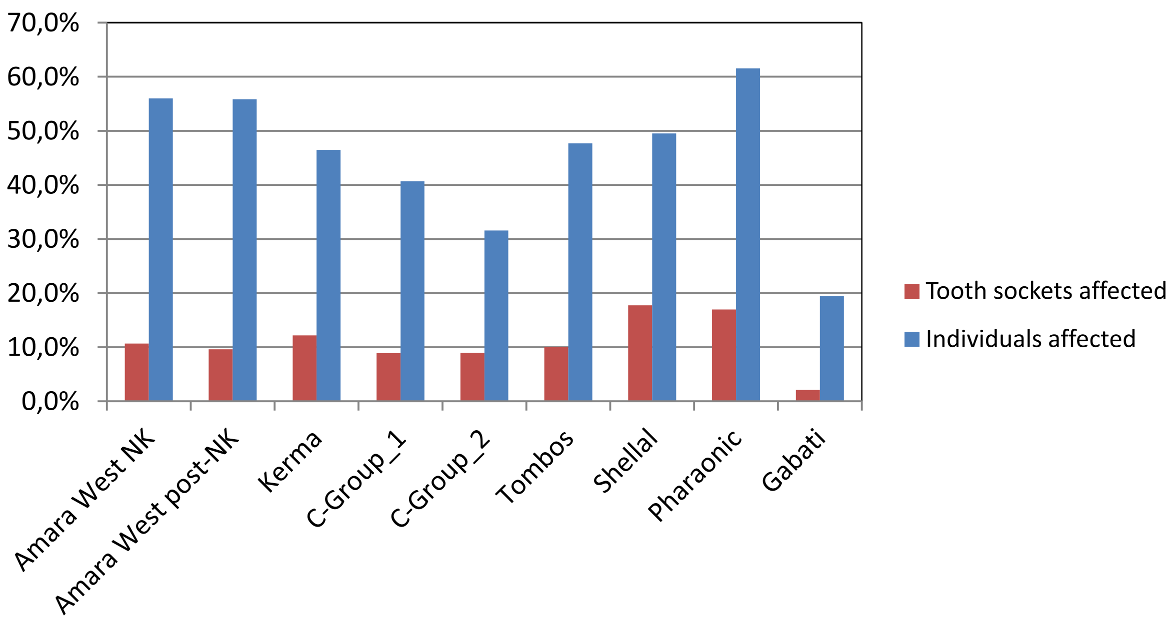

Figure 9.10 Prevalence of periapical lesions at Amara West and other sites in Egypt and Sudan (teeth/individuals affected compared to teeth/individuals preserved, see Table 9.6)

Site	Date	Tooth sockets affected			Individuals affected		
		n	N	%	n	N	%
Amara West NK	**1300–1070BC**	49	460	10,7	14	25	56,0
Amara West post-NK	**1070–800BC**	144	1502	9,6	43	77	55,8
Kerma[1]	**1750–1550BC**	230	1891	12	119	256	47
C-Group[1]	**2000–1600BC**	192	2156	9	83	204	41
C-Group[2]	**2000–1550BC**	77	859	9	12	38	36,4
Tombos[1]	**1400–1070BC**	82	821	10	31	65	48
Shellal[1]	**1500–1070BC**	84	474	18	51	103	50
Pharaonic[1]	**1650–1350BC**	80	472	17	40	65	62
Gabati[3]	**200BC–1100AD**	30	1438	2,1	28	144	19,2

Table 9.6 Prevalence of periapical lesion in different archaeological populations from Sudan and Egypt (n=number affected, N=total number observed); sources: [1]Buzon & Bombak, 2010; [2]Beckett & Lovell, 1994; [3]Judd, 2012: 39)

While the overall prevalence is relatively similar, significant diachronic differences were again observed when analysing age-categories separately. Young adult individuals in the post-New Kingdom group were found to have significantly higher rates of periapical lesions than New Kingdom young adults. In contrast, in middle adults the values were relatively similar. The formation of periapical lesions is progressive in nature and therefore the number of lesions usually increases and accumulates over time (Beckett & Lovell, 1994). The distribution of periapical lesions between different tooth types did not reveal any clear patterns and did vary considerably between the groups. Maxillary teeth generally seem to be more commonly affected by lesion formation than mandibular teeth. Low rates in the mandibular molars may be explained by higher rates of AMTL because, in the advanced stages of resorption, lesion cavities are equally obscured. Therefore, the shift in periapical lesion prevalence further supports the idea of significant deterioration of dental health during the post-New Kingdom period.

9.4.4. Antemortem tooth loss

Antemortem tooth loss is mainly the result of periapical lesions and periodontal disease (Lukacs, 1989), and therefore the high prevalence observable in New Kingdom and post-New Kingdom inhabitants from Amara West correlate well with equally high rates in other categories of dental disease. A high prevalence of tooth loss is another common characteristic of dentitions in archaeological populations of the Nile Valley region (Rose *et al.*, 1993); this is unsurprising in the light of generally high rates of all forms of dental disease. The inhabitants of Amara West represent no exception to this rule and in fact rates of AMTL rank amongst the highest observed in any of the comparative samples (see Figure 9.11 and Table 9.7). Given that both chronological samples from Amara West comprise relatively more young adult individuals than other populations with very high values, this finding becomes even more significant.

In diachronic comparison, the significant deterioration of dental health during the post-New Kingdom is similarly manifested in AMTL. In accordance with the trends observable in all other categories of dental pathology, the differences are particularly evident when only comparing young adult individuals. Due to the fact that AMTL arises as a consequence of a combination of dental pathologies which are all progressive in nature, the degree of AMTL is highly correlated with age. In middle adults, the rates are similar, attesting to the fact that AMTL is age-related and expected to accumulate throughout life. Therefore, its common occurrence in young adult individuals provides further evidence of poor dental health at Amara West.

AMTL is also a common complication of vitamin C-deficiency (scurvy). Scurvy leads to a general weakening of the collagen in the connective tissue. This also includes the highly collagenous periodontal ligament anchoring the teeth which leads to loosening of the teeth, intra-gingival haemorrhage and subsequent tooth loss (Aufderheide & Rodríguez-Martín, 1998: 311–312). Pathological changes on sub-adult remains indicate that, at least during the post-New Kingdom period, scurvy represented a prevalent health problem at Amara West (see 9.5.1.iii). Therefore, a certain underlying contribution of scurvy to the high prevalence of AMTL in the people living at Amara West has also to be taken into account.

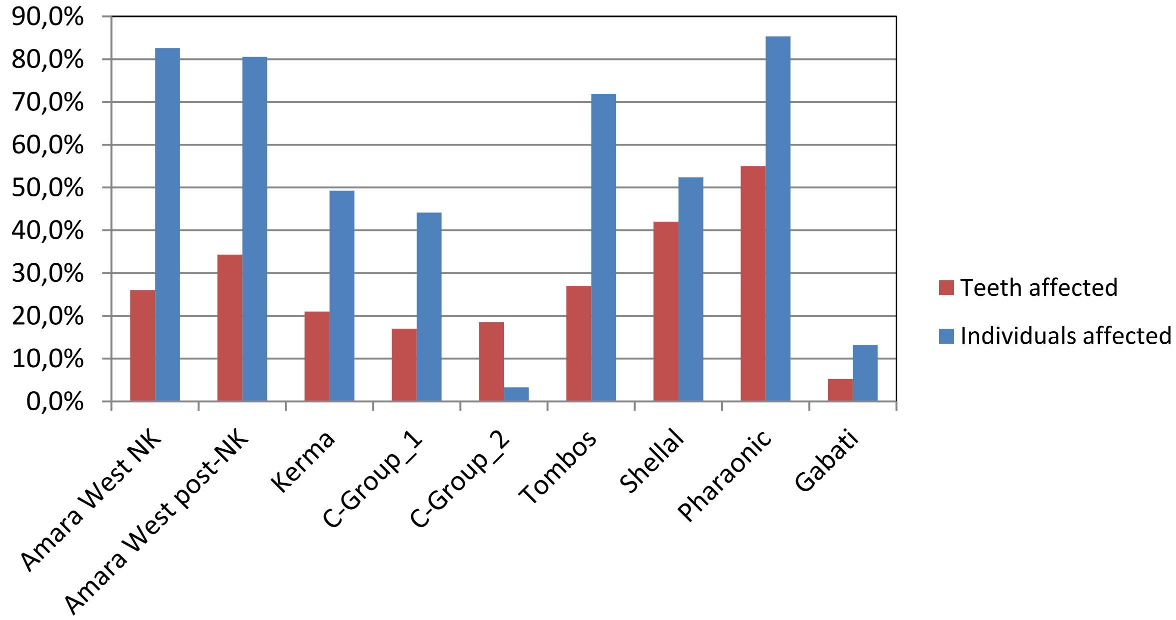

Figure 9.11 Prevalence of AMTL at Amara West and other comparative sites (teeth/individuals affected compared to teeth/individuals preserved, see Table 9.7)

Site	Date	Tooth sockets affected			Individuals affected		
		n	N	%	n	N	%
Amara West NK	**1300–1070BC**	122	469	26,6	19	23	82,6
Amara West post-NK	**1070–800BC**	511	1489	34,3	58	72	80,6
Kerma[1]	**1750–1550BC**	*496*	*1891*	*21*	130	264	49
C-Group[1]	**2000–1600BC**	450	2156	17	94	213	44
C-Group 2[2]	**2000–1550BC**	118	638	18,5	11	334	33,3
Tombos	**1400–1070BC**	*296*	*821*	*27*	46	64	72
Shellal[1]	**1500–1070BC**	*340*	*474*	*42*	55	105	52
Pharaonic[1]	**1650–1350BC**	*572*	*472*	*55*	64	75	85
Gabati[3]	**200BC–1100AD**	75	1438	5,3	19	144	13,2

Table 9.7 Antemortem tooth loss in various archaeological sites from Sudan and Egypt (italic letters: numbers given in the publication do not match percentages and therefore have to viewed with caution; n=number affected, N=total number observed; sources: [1]Buzon & Bombak, 2010; [2]Beckett & Lovell, 1994; [3]Judd, 2012: 39)

9.4.5. Dental calculus

Formation of mineralised dental plaque (calculus) is the result of a complex combination of dietary, genetic and other factors which is still not fully understood (Jin

& Yip, 2002, Hillson, 2005: 289). Bioarchaeological studies of dental health and diet traditionally rely on caries for interpretation, often together with AMTL and periapcial lesions, while the systematic study of dental calculus receives by far less attention (Greene *et al.*, 2005). Its presence was observed in 77.8% of the New Kingdom group and 66.7% of the post-New Kingdom groups. These values are relatively low when compared to the values given by Greene and co-workers (Greene *et al.*, 2005) (2005) who reported values between 83 and 96% in archaeological populations from Egypt and Sudan, including Hierakonpolis, Naqada and Semna South. Nevertheless, rates observed at Amara West are still distinctively higher than at Gabati or Hierakonpolis (see Figure 9.12 and Table 9.8). However, the observed rates at Amara West are almost certainly an underrepresentation of the true prevalence because of poor preservation and taphonomic damage to the teeth. Therefore, caution is warranted when interpreting the dental calculus data. Despite these limitations, the consistent presence of dental calculus in both samples indicates that environmental conditions and the composition of the diet were favourable to the development of dental calculus. This is further supported by the fact that it was already affecting sub-adults of the post-New Kingdom group, suggesting it was part of the overall life course for the population.

When comparing the two groups, significant differences were observed in the young adult group with significantly more dental calculus in New Kingdom individuals. The differences are statistically significant and thus may not be explained by taphonomic factors alone. It is possible that these differences indeed reflect dietary differences between the New Kingdom and the post-New Kingdom group. The main dietary precipitants are carbohydrates (sugar) and proteins (Lieverse, 1999). Remains of cereals, as well as abundant quantities of bones from cattle, sheep/goat and pigs found within the New Kingdom settlement, attest to a diet that would have certainly contained both types of nutrients. Therefore, these findings are consistent with the high degree of dental calculus observed in the groups from Amara West. Inferring dietary habits for individuals in the post-New Kingdom period remains difficult due to the lack of intact settlement layers or faunal remains. Carbon isotopic data obtained for the Amara West individuals indicates a similar reliance on C^3-cereals for both New Kingdom and post-New Kingdom individuals. Another possible cause is culturally induced food preferences. Smith (2003: 115–124) points out significant differences between Nubian and Egyptian food composition based on the analysis of residues in cooking vessels from the Middle Kingdom sites of Askut in Lower Nubia. At Amara

West, cultural changes are strongly indicated by the appearance of infants and children buried within the graves, as well as by significant changes in funerary ritual during the later part of the post-New Kingdom period, with the introduction of the niche burials. The breakdown of Egyptian control at the end of the New Kingdom may have also had an impact on the socio-economic structure of the settlement and led to changes in the availability of food sources. However, in the absence of occupation deposits from the later period it remains impossible to infer how much diet would have changed. Nevertheless, it also remains a possible explanation for the observed diachronic differences in dental calculus.

More distinctive temporal trends were observed with regard to the severity of dental calculus even though again these results have to be viewed with caution in light of taphonomic damage. While in the New Kingdom group the majority of the teeth were only "slightly" affected, during the post-New Kingdom period "moderate" dental calculus made up for almost as high a proportion as mild calculus. This discrepancy is also visible when viewed for each age group seperately. The more severe expressions seen in the post-New Kingdom group may be seen as directly related to the significant differences in dental caries between the two groups (see 9.4.2), and derive from the same dietary and physiological changes brought about by environmental deterioration affecting living conditions and diet at the settlement of Amara West.

Rates are somewhat higher in men, both during the New Kingdom and post-New Kingdom period. This trend is also commonly observed in living populations (Hillson, 1996: 260) as well as in groups from other archaeological sites (Greene *et al.*, 2005). However, it again has to be stressed that the values observed at Amara West may not be fully representative due to preservation issues.

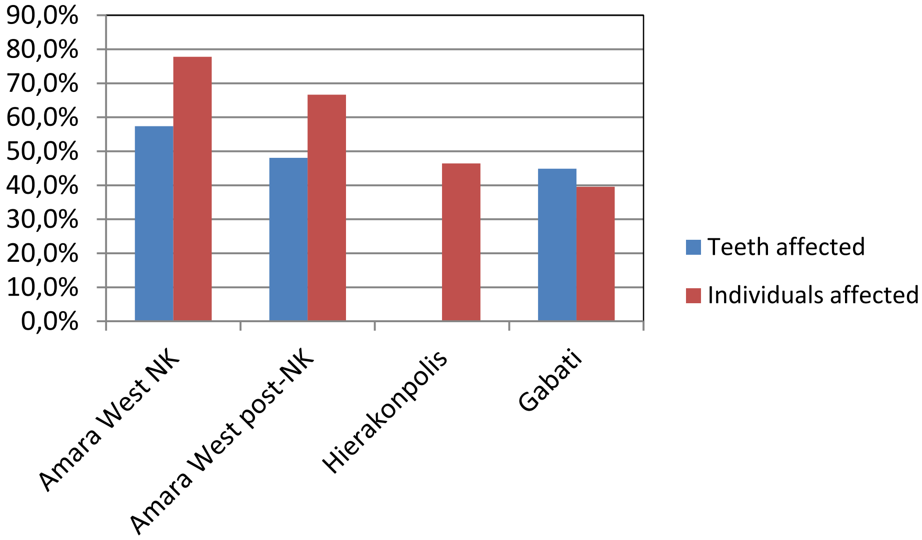

Figure 9.12 Comparison of dental calculus prevalence at Amara West and other comparative sites (teeth/individuals affected compared to teeth/ individuals observable, see Table 9.8)

Site	Date	Individuals			Teeth affected		
		n	N	%	n	N	%
Amara West NK	**1300–1070BC**	14	18	77.8	97	169	57.4
Amara West post-NK	**1070–800BC**	46	69	66.7	274	570	48.1
Hierakonpolis[1]	**2055–1700BC**	13	28	46.6	-	-	-
Gabati[2]	**200BC–1100AD**	57	144	39.6	645	1438	44.9

Table 9.8 Dental calculus in the people from Amara West and from other archaeological sites in Egypt and Sudan (n=number of individuals/ teeth with calculus, N=number of observable teeth/ individuals, [1]Irish, 2007, [2]Judd, 2012: 39)

9.4.6. Periodontal disease

Periodontal disease, manifested through horizontal loss of alveolar bone (Hillson, 1996: 263), was observed in the majority of individuals with dentitions preserved for observation, with very similar levels in both time periods. Multiple factors have been suggested to play a major role in the aetiology of alveolar bone loss. It is mainly linked to chronic inflammation of the gums caused by accumulation of plaque on the teeth (Hillson, 1996: 262). Factors such as mechanical loading due to high levels of attrition have also been shown to be a major influence (Clarke & Hirsch, 1991a). Periodontal disease represents a very common finding in human remains from archaeological contexts worldwide (Larsen, 1997: 80). However, the diagnosis of periodontal disease has been contested, and it remains unclear to what extent the changes seen in archaeological human remains represent actual evidence of periodontal disease or whether they reflect responses to biomechanical stress related to attrition and subsequent continuing eruption (Clarke *et al.*, 1986, Glass, 1991). Its prevalence may therefore be highly overrated Moreover, different methodologies applied leave inter-site comparison generally difficult. (Roberts & Manchester, 2005: 74).

In the Sudanese sites used for comparison in this study, alveolar bone loss was not included in the spectrum of dental diseases analysed, and therefore no comparative data from Sudan exists. However, the high prevalence observed at Amara West correlates well with high levels of attrition observed in both groups. Dental calculus was equally common and may also have contributed. Similar to other forms of dental disease, alveolar bone loss is a progressive process, and its severity increases with age. The very early onset of periodontal disease, already affecting a small proportion of the sub-adult individuals from the post-New Kingdom period, therefore lends further support to the notion that people living at Amara West experienced poor dental health.

9.4.7. Dental enamel hypoplasias

Dental enamel hypoplasias (DEH) were relatively frequently observed in the groups from Amara West, with 35.0% of the New Kingdom population and 47.0% of the post-New Kingdom individuals displaying at least two hypoplastic teeth. These rates are amongst the highest observed in all of the comparative samples from Sudan and Egypt, with the post-New Kingdom group having the highest frequency of all groups (see Figure 9.13 and Table 9.9). Comparability is somewhat limited due to discrepancies of methods applied in scoring DEH. For example, Buzon only analysed incisors, canines and premolars but included all individuals with at least one anterior tooth was present (Buzon, 2006b).

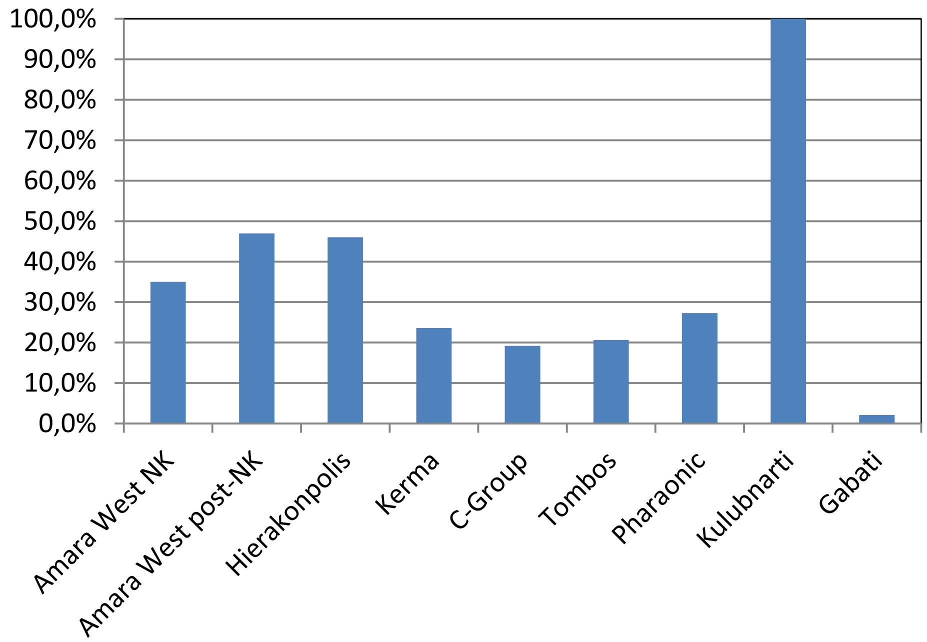

Figure 9.13 Individuals with dental enamel hypoplasias. Comparison of data from Amara West and other comparative sites in Egypt and Sudan (individuals affected compared to individuals observable, see Table 9.9)

Site	Date	n	N	%
Amara West NK	**1300–1070BC**	7	20	35,0
Amara West post-NK	**1070–800BC**	31	66	47,0
Hierakonpolis[1]	**3800–3600BC**	58	126	46,0
Kerma[2]	**1750–1550BC**	17	72	23,6
C-Group[2]	**2000–1600BC**	14	73	19,2
Tombos[2]	**1400–1070BC**	13	63	20,6
Pharaonic[2]	**1650–1350BC**	3	11	27,3
Kulubnarti[3]	**550–1450AD**	87	87	100
Gabati[4]	**200BC–1100AD**	3	144	2,1

Table 9.9 Individuals with dental enamel hypoplasias at Amara West and other sites in Sudan and Egypt (n=number affected, N=total number observed; sources: [1]Gamza & Irish, 2007, [2]Buzon, 2010, [3]Van Gerven, Beck & Hummert, 1990, [4]Judd, 2012: 39)

In diachronic comparison, despite a slight bias in terms of sample size, the DEH data prevalence clearly show a statistically significant increase in the post-New Kingdom period. DEH represent disruptions to the process of formation of tooth enamel, mainly caused by systemic stress due to malnutrition, and to a lesser degree chronic diseases or any other insults to the organism (Goodman & Rose, 1991, Ogden, 2008, Seow, 2013). The occurrence of DEH was further compared between male and female individuals but revealed only slightly higher values in males, which were far from being statistically significant. Therefore, the data do not indicate any differences in access to food or exposure to stressors between male and female children. The sharp rise during the post-New Kingdom period indicates that children growing up at this time experienced a much higher degree of physiological stress. Potential explanations include a higher disease burden in the environment, increased levels of undernutrition leading to metabolic diseases, and a weaker immune response which would have left children more susceptible to disease. This finding is very consistent with other lines of bioarchaeological evidence which will be discussed in more detail over the course of this chapter.

9.5. Orbital lesions

Bone changes on the roof of the orbits were generally very common in both time periods. However, marked changes were observed in the "grades" of the observed lesions. While during the New Kingdom simple vessel impressions (grade 1) dominated over true porosities (Grades 2 and 3), more porous lesions where observed overall in the post-New Kingdom sample. Interpreting these lesions is not straightforward as a number of different underlying disease processes have the ability to produce very similar changes (Ortner, 2003: 372). Therefore, together with being amongst the most commonly described lesions in palaeopathological research, they also have been amongst the field's most contested issues (Waldron, 2009: 136–137, Walker *et al.*, 2009). For a detailed discussion of orbital lesions and the controversy surrounding their aetiology see section 4.3.4.

9.5.1.i. Anaemia

Porosities in the orbital cavity, together with porosities occurring on the skull vault are most commonly attributed to acquired or genetic forms of anaemia (e.g. Stuart-Macadam, 1991, Ortner, 2003: 306). Skeletal changes are caused by expansion of the haematopoietic marrow leading to hypertrophy, and thinning and porosity of the ectocranial cortical bone (Caffey, 1937). Anaemia generally refers to disorders of the red blood cells (Ortner, 2003: 363), and the most commonly occurring forms of anaemia are related to iron-deficiency (Stuart-Macadam, 1992, Ortner, 2003: 369). The main causes for iron-deficiency are: insufficient iron intake from the diet, excessive blood loss secondary to haematoma, parasitic or infectious diseases, and trauma, as well as disturbances in iron-absorption or storage which can be caused by chronic diarrhoea (Stuart-Macadam, 1992). However, based on clinical evidence iron-deficiency anemia recently has been discared as a possible cause for orbital lesions in skeletal human remains (Walker *et al.*, 2009; see section 4.3.4) and palaeopathology has increasingly turned to megaloblastic anaemia due to malaria as a likely cause for high frequencies of cribra orbitalia in many skeletal samples from various geographic and chronological backgrounds (e.g. Buckley & Tayles, 2003, Gowland & Garnsey, 2010, Gowland & Western, 2012). Malaria is a protozoan infection, transmitted by different forms of mosquitoes (Eddleston *et al.*, 2008: 32). In modern Sudan, it represents one of the leading causes of death amongst children under five years (UNICEF, 2013), and is responsible for one third of hospitalisations of adults and children in the north of the country (Malcolm *et al.*, 2007). Its presence in ancient Egypt has been demonstrated repeatedly through immunobiological detection of antigens (Miller *et al.*, 1994), and aDNA analysis of *Plasmodium falciparium,* the parasite causing the most dangerous form of malaria, has been attested in ancient Egyptian mummified remains dating to *c.* 1500BC (Nerlich *et al.*, 2008). Similar findings from Sudan are so far missing and therefore its distribution and epidemiology remains unknown. However, spread of the disease into Egypt from more southern regions of Africa is assumed to have occurred via the Nile Valley route, and thus its presence in Egypt also presupposes a presence in the Middle Nile Valley (Malcolm *et al.*, 2007). At least up until the New Kingdom period, the environmental conditions in Nubia would have been favourable for sustaining adequate populations of *Anopheles arabiensis*, the main malaria vector in Northern Sudan. Field studies in the northern Sudanese Nile Valley have shown, that stagnant pools of water remaining in river beds after the floods provide ideal breeding conditions for *A. arabiensis,* leading to a considerable population increase, while during the flood season itself numbers decreased (Dukeen & Omer, 1986). Therefore, it stands as a potential explanation for the observed frequency of examples at Amara West too.

Another type of anaemia potentially leading to the changes observed in skeletal remains is megaloblastic anaemia (Walker *et al.*, 2009). This anaemia affecting megaloblastic cells in blood marrow, can arise from a number of conditions but is most commonly caused by deficiency in Vitamin B12 and/or folic acid (Schick, 2012). While dietary reasons very rarely account for Vitamin B12 deficiency, it is more commonly linked to various parasitic gastrointestinal diseases (Walker *et al.*, 2009), some of which may have well been present at Amara West as well. Folic acid deficiency on the other hand is mainly linked to food preparation techniques, because it is destroyed by excessive heating of food, especially when diluted in water. Ways of food processing at Amara West are yet unknown but the possibility of folic acid deficiency contributing to megaloblastic anaemia cannot be excluded.

9.5.1.ii. Inflammatory conditions of the eye

A possible connection between certain inflammatory diseases of the eye and porosity in the orbital roof were suspected by Sandison back in 1967, even though this differential diagnostic option has received by far less attention than anaemia in palaeopathology. Histological research performed on porotic lesions has confirmed this early notion, showing that a large number of observed lesions in the study was not caused by marrow hypertrophy but rather represents periosteal new bone formation secondary to inflammation (Wapler *et al.*, 2004). Chronic inflammation in soft tissue generally stimulates increased vascular activity and can, if occurring in the vicinity of bone, spread to the periosteum where it leads to new bone deposition (Weston, 2008). Inflammation of the eye and the underlying orbital bone can arise as a primary condition, or secondary to a large number of different viral, bacterial, fungal and parasitic infections, neoplastic conditions, endocrine diseases, trauma, and the result of infiltration by foreign objects (Cockerham *et al.*, 2003). In addition, orbital involvement can also spread secondarily from infections of the frontal and paranasal sinuses (Garrity, 2012), as well as from endocranial pathologies.

Differentiating between lesions caused by anaemia and inflammatory lesions is difficult without further invasive histological analysis, which has not been carried out on the individuals from Amara West (Wapler *et al.*, 2004). While haemolytic anaemia due to malaria is certainly within reason, the environment at Amara West would have also provided an ideal habitat for various infectious agents causing chronic inflammation of the eye and orbits. More than half of the lesions observed in the New Kingdom sample, and over a third of those in the post-New Kingdom sample, are represented by changes expressed as vessel impressions associated with slight hypertrophy in the orbital roof (grade 1). These are similar in morphological appearance to skeletal changes associated with NBF subsequent to inflammation in other parts of the skeleton. Eye diseases were certainly a highly prevalent problem in ancient Egypt (Sandison, 1967). The most comprehensive evidence is provided by the Papyrus Ebers which contains an entire section concerned with a variety of different eye diseases and their treatment (Westendorf, 1999). Further descriptions are found in other medical texts, supported by a wealth of iconographic and textual evidence attesting to the fact that blindness was a common problem (Sandison, 1967). The exact identification of these diseases has been very much debated, but tentative diagnoses include opthalmia, trachoma, trichuris, staphyloma and potentially tumors (e.g. Feigenbaum, 1958, Sandison, 1967, Nunn, 1996: 197–202, Andersen, 1997). Therefore, chronic eye diseases represent a very likely differential diagnostic option for the changes observed in the orbital roofs in the individuals from Amara West too. Furthermore, an association with chronic sinus infection cannot be excluded.

Two more distinctive examples of orbital infection were detected in the post-New Kingdom dataset, featuring circular depressions on the lateral side of the roof of the orbit, surrounded by remodelled new bone formation. The lesions are consistent with the location of the lacrimal gland (Rootman, 2003: 21). Inflammation of the lacrimal gland (dacryoadenitis) can be caused by bacterial, viral and parasitic infections, including tuberculosis, sarcoidosis and leprosy, as well as rupture of dermatoid cysts (Rootman, 2003: 463). Echinococcosis can cause cysts in the lacrimal glands which also have the potential to erode into the bony roof of the orbit (Rootman, 2003: 467), and potentially can cause circular lesions similar to those seen in the individuals from Amara West. Similar pathological lesions were observed in skulls from Australia and assumed to be consistent with a diagnosis of trachoma, even though this diagnosis is only circumstantial (Webb, 1990). Trachoma is a bacterial infection of the conjunctiva caused by *Chlamydia trachomatis* primarily affecting the upper conjunctiva (Taylor, 2013). Transmission of the disease usually occurs between infected humans or flies. Prolonged or recurring infection exacerbates inflammation, consequently causing scarring and formation of abscesses in the conjunctiva. Eventually, chronic infections lead to blindness, and trachoma, represents the single most common cause for acquired blindness today (Wright *et al.*, 2008). Those most at risk are children, even though symptoms can persist into adulthood.

The antiquity of trachoma is still unknown even though textual evidence suggests that it is indeed a disease of considerable antiquity (reviewed in Aufderheide & Rodríguez-Martín, 1998: 251). Diseases of the eye tentatively identified as trachoma are described in the Papyrus Ebers (*c.* 1500BC) (Møller, 1932). In Sudan, trachoma was found to be a major health problem amongst Nubian children by British medical officials in the 1930s (MacCallan, 1934) and it is still highly prevalent all over Sudan today (Hassan *et al.*, 2011). Palaeopathological evidence thought to result from trachoma have been reported in Native American populations (Euber *et al.*, 2007), and also in Egypt (Malnasi, 2010) and Sudan (Jakob & Walser III, 2013) even though the evidence is by no means conclusive. Nevertheless, trachoma remains a plausible explanation for the observed circular lesions. The transmission of trachoma is linked to factors such as poor sanitation, inadequate access to clean water and closeness to animals (Wright *et al.*, 2008), and thus its tentative presence at Amara West provides further indications of levels of hygiene and sanitary conditions within the settlement at Amara West.

However, other underlying causes, such as tuberculosis or echinoccocosis, cannot be excluded since both diseases may have been present at Amara West. Tuberculosis will be discussed in more detail below (see 9.6.3.iii). Cystic echinoccocosis, also referred to as hyatid disease, is a parasitic infection caused by the dog tape worm (*echinococcus granulosus*). The parasite is transmitted through the faeces of dogs and jackals. Following infection, cysts develop in the liver as well as in other organs of the body (Eddleston *et al.*, 2008). The disease is relatively uncommon in Sudan today (Elmahdi *et al.*, 2004). In ancient Egyptian remains, only one example of a hyatid cyst caused by the parasite has been identified to date, attesting to the fact that it was also a health problem in the region in antiquity (Sandison & Tapp, 1998).

9.5.1.iii. Scurvy

Scurvy (chronic lack of Vitamin C) and to a lesser degree rickets (chronic Vitamin D deficiency) in sub-adults are also known to produce lesions, which can be similar in appearance to porosity resulting from marrow hypoplasia in anaemia (e.g. Ortner, 2003: 385–386, 394, Brown & Ortner, 2009). Vitamin C (ascorbic acid) is essential for the normal synthesis of collagen in the body and has to be obtained by humans through food and drink. Prolonged inadequate supply results in deficient collagen which is particularly problematic in the growing skeleton of infants. Skeletal changes caused by scurvy are structural loss in the metaphyseal areas of long bones and ribs leading to fractures, as well as subperiosteal haemorrhage subsequent to a general weakening of the blood vessel walls, which can stimulate new bone deposition (Ortner, 2003: 383–384). Changes in the orbital bone surfaces result from haemorrhage into the orbits which then can lead to deposition of newly formed bone (Ortner, 2003: 385). As scurvy is a systemic process, these lesions usually occur in multiple locations. Preferential sites for haemorrhage and consequent new bone formation are the greater wings of the sphenoid bones, temporal bones, the posterior side of the maxilla, ectoand endocranial surfaces of the skull vault, and in the mandible (e.g. Ortner & Ericksen, 1997, Brickley & Ives, 2006, Mays, 2008, Brown & Ortner, 2009).

In five post-New Kingdom sub-adults, orbital lesions characterised by hypertrophy and marked porosity in the orbital roof and floor were found associated with porosity and new bone deposition on the maxillae, sphenoid and zygomatic bones. In a 3–4 year old (Sk210-3) and a 5–6 year old child (Sk210-4), stellate vascular impressions were observed on the superior aspect of the parietal bones (see Figures III.82–III.85). Resulting from increased vascular activity, similar lesions were also observed by Brown & Ortner (2009) and ascribed to scurvy. A 4–5 year old child, Sk314-13, further displays increased porosity in the supraspinatous fossa, together with woven bone deposition in the infraspinatous fossa of the right scapula. Skeletal changes in the scapula have also been observed by Ortner *et al.* (1999), Brickley & Ives (2006) and Geber & Murphy (2012), their diagnosis supported by historical data on children suffering from scurvy (Barlow, 1883, cited by Brickley & Ives, 2006). The most extensive cranial changes were observed in a 0.5–1.5 year old child (Sk243-1, see Figures III.86–88) from a chamber tomb in cemetery C. In addition to porosity on the orbital roofs, porous new bone deposition was observed on the orbital floors, along the suprorbital ridges, and on the inner side of the frontal bone. On both parietal bones plaque-like new bone formation was accompanied by extensive vascular impressions. Increased porosity was also observed on the endocranial surface and outer sides of the greater wings of the sphenoid bones, the palateal bones, as well as in the supra- and infraspinatous fossae of the scapulae.

The earliest mention of scurvy comes from the Papyrus Ebers attesting that the disease did affect people in ancient Egypt (Goebel, 2013). Scurvy is a common characteristic of prolonged periods of drought, significantly contributing to increased morbidity and mortality (Cheung *et al.*, 2003, WHO, 2013b). 20th century reports also exist for Nubia, citing scurvy to be a common, seasonally occurring problem throughout the region (Corkill, 1949). A high prevalence of skeletal changes potentially caused by scurvy was also reported in the population from Mis Island (Hurst, 2013). However, the archaeobotanical spectrum recovered from within the New Kingdom at the Amara West settlement shows examples of several plants which would have provided sources of Vitamin C, such as Christ's Thorn, watermelons and figs (Ryan *et al.*, 2012). In the post-New Kingdom, the availability of these plants appears far less certain. Palaeoenvironmental and isotopic data indicates severe environmental deterioration and aridification during the later phases of occupation of Amara West (see Spencer *et al.*, 2012; see chapter 3). Droughts and consequent crop failure are likely to have occurred as a result of these changes. Therefore, interpreting the observed pathological orbital lesions as evidence of scurvy affecting post-New Kingdom sub-adults seems reasonable. This adds yet another piece of evidence highlighting the difficulties associated with living at Amara West during the later stages of occupation. Children displaying skeletal evidence of scurvy were found both in chamber tombs (G243, G314) as well as in niche burials (G210, G246) indicating that scurvy was already a health problem during the early post-New Kingdom period.

9.6. Infectious diseases

9.6.1. New bone formation on the long bones

New bone formation (NBF) on the long bones was systematically analysed as a means of assessing the burden of non-specific inflammatory diseases and trauma in the living environment of Amara West. While NBF in the upper extremity bones and in the femora was almost completely absent both in New Kingdom and post-New Kingdom individuals, considerable levels could be observed in the tibiae and fibulae. Even though the presence of NBF in the long bones, particularly in the tibiae and fibulae, is a commonly used marker of “non-specific” infection and included in a large number of bioarchaeological studies (e.g. Larsen, 1997: 84, Goodman & Martin, 2002, Buzon, 2006b, Buzon & Judd, 2008), research in recent years has brought about considerable doubts as to the specificity of the observed changes and therefore their validity as a marker of infectious disease prevalence (e.g. Weston, 2008). Potential causes for NBF in the long bones of the lower limbs range from haemorrhage resulting from localised blunt trauma, to primary infections as a consequence of open wounds, secondary infection due to a systemic disease, varicose veins and even muscular activity (Ortner, 2003, Weston, 2008: 206–207, Soltysiak, 2012 (Early View)). Moreover, it is a common sign found in people suffering from specific infectious diseases such as leprosy, syphilis or tuberculosis, even though additional differential diagnostic features are needed to diagnose any of these lesions with any certainty. The predominance of NBF in the tibiae and fibulae is a common finding in palaeopathological studies in general. Reasons for the preferential involvement of the tibia still remain unresolved (Ortner, 2003: 209). It has been suggested that the relatively small amount of soft tissue surrounding the shaft, as well as low vascular and physiological activity along the anterior and posterior sides of the tibia, renders the bone more prone to infection (Larsen, 1997: 85). Periostitis in the tibia is also a common complication of chronic mechanical stress due to muscular activity (Hertel, 2013). As such, it is a well documented and common problem in professional and recreational athletes but also in people whose occupations involve physical activity, such as soldiers or dancers (Bong *et al.*, 2005, Reshef & Guelich, 2012). Inflammation of the periosteum develops as a response to chronic stress of the muscles attaching to the periosteum and is most commonly seen on the medial side of the tibia.

Differential diagnosis of NBF on the long bones can only be achieved if further differential diagnostic features are present, or through the application of histopathological or biomolecular techniques (e.g. Schultz, 2001, Ortner, 2003: 206), even though neither of these options necessarily guarantees a secure answer. However, neither of these options was available for the human remains at Amara West. In addition, it has also been suggested repeatedly that bilateral involvement would allow for attributing the lesions to an infectious origin rather than traumatic (Goodman & Martin, 2002). This approach also remains questionable since both musculoskeletal activity as well as varicose veins would presumably cause bilateral changes too. The potential causes of the observed skeletal lesions vary greatly with regard to their significance and relationship with the living environment and disease burden for the population, and therefore in the absence of a better diagnosis the discussion has to remain very generalised and the interpretation of these findings are somewhat limited.

The data clearly indicate that in most individuals NBF in the tibiae and fibulae occurred bilaterally. Infectious diseases could have certainly affected the people at Amara West and may account for the observed changes. The variety of infectious diseases that can manifest themselves as NBF in the tibiae and fibulae is considerable (Ortner, 2003: 207–208) and the environment and settlement at Amara West would have certainly provided an ideal habitat for a wide range of infectious agents. Close proximity to animals, a high number of people within a relatively small space, and poor sanitation in the town would have all predisposed people, facilitating the spread and transmission of infectious diseases. A high degree of mechanical stress resulting in activity-related tibial periostitis appears a similarly likely explanation for the individuals at Amara West. Based on the archaeological and environmental context we can relatively confidently assume a mainly agricultural subsistence at Amara West (see Section 9.7.2 for a more detailed discussion). As constant physical activity would seem a prerequisite of success of an agricultural society, a high prevalence of degenerative joint diseases associated with overuse appears a plausible explanation.

9.6.2. Diachronic trends in NBF

Regardless of the underlying causes, the post-New Kingdom period saw a marked increase in NBF prevalence. One might again argue along the lines of the "osteological paradox" (Wood *et al.*, 1992) that in fact the higher frequency of bone changes suggests a better immune response, which allowed more people to survive long enough to develop skeletal responses, whereas during the New Kingdom period people would have succumbed to the causative diseases before NBF could have started. Such a possibility of course can never be excluded. However, it would not be consistent with other lines of evidence observed at Amara West. The demographic profile instead suggests a lower age-at-death during the post-New Kingdom samples. Moreover, the infectious diseases leading to NBF in the tibiae and fibulae are very rarely associated with significant mortality. Therefore, it appears reasonable to assume the observed increase indeed indicates changes in the exposure or vulnerability to the agents causing NBF.

Experience from areas struggling with ongoing desertification today shows that an increase in infectious water-, food- and air-borne diseases due to poor hygiene and lack of clean water is amongst the major health challenges in these areas (WHO, 2013c). However, due to its riverside location, people living in the area of Amara West would have always had access to sufficient quantities of clean river water, and therefore contaminated water or shortage of water would have not posed significant problems for the inhabitants. The impact of a changing disease environment can further be exacerbated by deteriorating nutritional status and higher levels of environmental pressure, which consequently leads to a weakened immune system and leaves people more vulnerable to infectious diseases, a problem that is well evidence in areas of droughts (Stanke *et al.*, 2013). The increase in periosteal NBF may also be related to increasing biomechanical demands brought about by agricultural intensification which is very well evidenced and a necessary behavioural response in areas experiencing aridification (Middleton, 1993).

Alternatively, increasing population density has to be considered as an explanation too. Archaeological evidence suggests considerable changes in settlement structure, transitioning from a planned to heterogeneous, growing city occurring from the mid–

late 19th Dynasty (*c.*1200BC) onwards (Spencer, 2014c). Within the town walls, the magazines of the early settlement gave way to smaller housing units of increasing density (see Figure 9.14). Settlement activity expanded beyond the town walls, providing further evidence of an increasing number of people present in the town. A positive correlation between increased population size and levels of infectious diseases is well evidenced in the bioarchaeological and historical record across the globe (McKeown, 1988, Larsen, 1997: 88, Meade & Earickson, 2000: 136–140). A large set of factors accounts for this relationship. High population density and crowded living environments facilitate transmission of diseases. The increasing amount of sewage and waste, often coupled with insufficient management strategies creates improved and enlarged breeding habitats for disease vectors. Consequently, the diachronic differences in bilateral NBF at Amara West may also reflect increased pathogen load brought about by increasingly crowded living conditions within the settlement.

Figure 9.14 Dense cluster of small houses in area E13 at Amara West (© S. Green)

Rates of NBF in the tibiae are generally relatively similar throughout populations from archaeological sites in Sudan (see Figure 9.15 and Table 9.10). In comparison with other archaeological populations in Sudan, the New Kingdom group is well within the range observed in the other groups. The post-New Kingdom individuals from Amara West however show markedly higher values than any other groups. Despite cultural differences, in terms of ecological parameters and living environment, all groups can be assumed to represent relatively similar riverine, agricultural communities exposed to a similar spectrum of diseases. The higher values observed in the post-New Kingdom periods could therefore be interpreted as another piece of evidence that living conditions after the end of the New Kingdom period deteriorated, not only because of higher levels of pathogens, but perhaps brought about by increased environmental pressure and consequent decreased immune resistance through malnutrition and physiological stress.

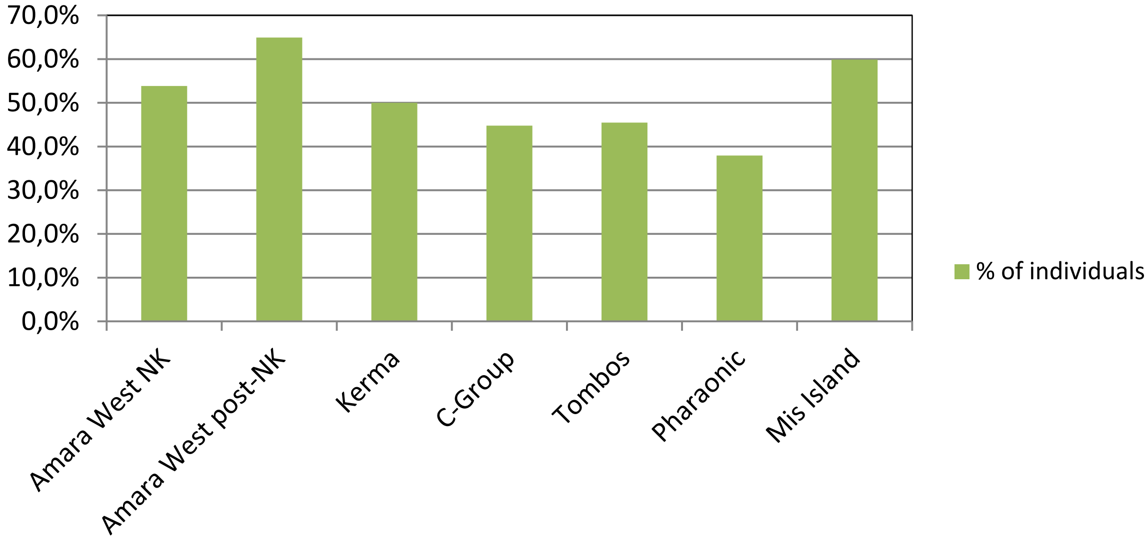

Figure 9.15 Comparison of individuals suffering from bilateral NBF (individuals affected compared to individuals observable, see Table 9.10)

Site	Date	n	N	%
Amara West NK	**1300–1070BC**	7	13	46.2%
Amara West post-NK	**1070–800BC**	37	57	64.7%
Kerma[1]	**1750–1550BC**	52	104	50.0%
C-Group[1]	**2000–1600BC**	30	67	44.8%
Tombos[1]	**1500–1070BC**	15	33	45.5%
Pharaonic[1]	**1500–1070BC**	11	29	37.9%
Mis Island[2]	**300–1400AD**	109	182	59.9%

Table 9.10 Comparison of bilateral NBF in the tibia between Amara West individuals and individuals from other Sudanese sites (n=number of individuals with both tibiae affected, N=total number with both tibiae observable; sources [1]Buzon, 2006, [2]Hurst, 2013)

9.6.3. Respiratory diseases

9.6.3.i. General remarks

Skeletal evidence at Amara West suggests a high prevalence of inflammatory diseases of the upper and lower respiratory tracts with new bone formation in the maxillary sinuses being present in 84,2% of the New Kingdom individuals and 62.5% of the post-New Kingdom individuals, and new bone formation on the ribs affecting 60.0% and 54.2% of the population, respectively. These values are exceedingly high, a notion confirmed when compared to published data from other sites (see Table 9.11) even though only a small number of sites are available for comparison, both in the

Nile Valley but also elsewhere. Attributing the observed lesions to a specific cause remains difficult due to the absence of any further differential diagnostic criteria or biomolecular analysis. However, taking into account contextual data about the habitat and living environment, several causes require particular attention.

Site	Date	Rib NBF			Sinusitis		
		n	N	%	n	N	%
Amara West NK	**1300–1100BC**	15	25	60.0	16	19	84.2
Amara West post-NK	**1100–800BC**	39	72	54.2	30	48	62.5
Gabati Meroitic[1]	**200BC–200AD**	5	80	6.3	24	72	33.3
Gabati Post-Meroitic[1]	**200–1100AD**	1	54	1.9	2	30	7
Kulubnarti[2]	**550–1450AD**	-	-	-	22	101	22.2

Table 9.11 Comparison of individuals affected by chronic respiratory diseases between Amara West and other archaeological sites in Sudan (n=number of individuals with ribs/ sinuses affected, N=number of individuals with ribs/sinuses preserved, data sources: [1]Judd, 2012: 60, [2]Roberts, 2007)

9.6.3.ii. Environmental related respiratory diseases

Reasons for the high prevalence of inflammatory disease of the respiratory tract could be sought in a high degree of environmental pollution affecting the people living at Amara West. Long term exposure to air pollutants arising from smoke, dust or sand significantly increases the risk of contracting infectious diseases of the respiratory system (Newman, 2012), the lungs becoming more susceptible. The causal relationship between habitual exposure to smoke from biogenic fuels and coal and chronic respiratory diseases has been consistently demonstrated by a large number of recent studies in developing countries (e.g. Chen *et al.*, 1990, Kaplan, 2010, Perez-Padilla *et al.*, 2010, Sood, 2012). This has also been used as a likely explanation by a number of palaeopathological studies which have revealed high prevalence rates of NBF in the maxillary sinuses and internal (visceral) surfaces of the ribs in past human populations comparable to rates observed in modern developing countries (e.g. Pfeiffer, 1991, Lambert, 2002, Roberts, 2007). Archaeological and historical evidence suggests that habitual exposure to smoke from wood fires in poorly ventilated areas for food preparation, ceramic production, metal work or other manufacturing purposes, would have been a common problem in past human populations in general. This is supported by palaeo-histopathological research on mummified human remains from ancient Egypt (Sandison & Tapp, 1998) and elsewhere (Munizaga *et al.*, 1975, Pabst & Hofer, 1998, Zimmerman, 1998) revealing several examples of anthracosis (deposition of charcoal particles) as well as silicosis (sand deposition) in lung tissue. Both conditions, summarised under the general term "pneumoconiosis", usually build up through habitual exposure to poor air quality over long periods of time (>20 years). Even though they do not cause any symptoms directly, infiltration and consequent blockage and damage of the tissue surrounding the bronchioles significantly increases the risk of pulmonary infections (Newman, 2008b, a)

Identifying environmental risk factors within the New Kingdom settlement of Amara West can easily be achieved. Within the settlement of Amara West, data indicate that exposure to smoke in poorly ventilated areas would have been a common occupational hazard for a least some parts of the population (Spencer, 2014b, a). Batteries of up to eight bread ovens are either found in separate rooms of houses or in small courtyards, perhaps shared between different households (e.g. E13.13, see Figure 9.16). Some of these spaces also had firepits, perhaps for making charcoal, and accumulations of ash from ongoing use. Roofing fragments recovered from the oven rooms, such as in E13.4.2 with a floor space of only about $6m^2$, suggest that at least some would have been entirely roofed. Other spaces, like the oven courts, may have been left unroofed but, due to the small space, would nevertheless have not allowed for adequate ventilation. Small scale industrial kilns for the production of pottery, metal and possibly faience were also identified on two occasions, both of them being situated in very small courtyard areas which would have been surrounded by high mudbrick walls. It appears very likely that these rooms would have filled with smoke, exposing those using the rooms to significant amounts of charcoal particles in the air and putting people at high risk of developing anthracosis.

Figure 9.16 Bread ovens in a house at Amara West

Figure 9.17 Air pollution through aeolian sand at Amara West during a dust storm in February 2011 (© M. Shepperson)

Other environmental pollutants, shown to have similarly detrimental effects on respiratory health after long-term exposure are sand and dust (silicosis or sand pneumoconiosis) (Newman, 2008b). Palaeopathological evidence has been found in several ancient Egyptian mummies, including a Middle Egyptian individual dating to the 12th Dynasty (*c.* 1990–1780BC) and an individual from Thebes dating to the 18th Dynasty (*c.* 1550-1290BC) (reviewed by Rowling, 1967, Sandison & Tapp, 1998). Micromorphological analysis indicates considerable amounts of sand on floors and in other occupation deposits of the later phases of use of the town. This is likely to represent evidence of recurring sand storms and/or heavy winds transporting sand from the Sahara extending to the north of the settlement (Dalton, Forthcoming, see Figure 9.17). Architectural modifications within houses, increasingly common from Phase IV onwards, presumably represent responses to increasing sand infiltration and lends further support to the notion that windblown sand started to become a major problem from at least 1200BC onwards. Even though the extent, duration and frequency of these episodes remain unknown, the amount of sand within the deposits, together with the scale of architectural changes, suggests that the amount of sand within the air could have been sufficient to impact on respiratory health.

9.6.3.iii. Tuberculosis (TB)

The most extensively investigated cause of new bone formation on the ribs is TB (e.g. Kelley & Micozzi, 1984, Roberts *et al.*, 1994, Roberts *et al.*, 1998, Matos & Santos, 2006, Santos & Roberts, 2006). The presence of TB in ancient Egypt and Nubia from at least *c.* 3000BC has been recognised based on the finding of unambiguous bone changes in the spine in the days of the Archaeological Survey of Nubia (Smith & Derry, 1910). Since then, a significant amount of skeletal (Buikstra *et al.*, 1993) and biomolecular evidence (e.g. Zink *et al.*, 2003) can be added to the body of literature, attesting to the fact that TB posed a common health problem in the Middle and Lower Nile Valley. Tuberculosis is still endemic in Sudan today (WHO, 2013a). Its prevalence is rising again due to the increase of multi-drug resistant strains, making the disease a major cause of mortality and morbidity amongst children and adults (Sharaf Eldin *et al.*, 2011). The town at Amara West would have certainly provided a suitable environment for the transmission of TB. Common risk factors predisposing people to contracting TB such as poor hygiene, dietary deficiencies, close relationship to animals (see Figure 9.18) and crowded living conditions (Roberts, 2008) would have certainly affected the people living at ancient Amara West. However, in the absence of unambiguous pathological lesions caused by TB in the skeletal remains from Amara West, it remains unknown whether or to what extent TB could have been the underlying cause of rib lesion identified.

Figure 9.18 Animal pens near the Nubian village of Kulb at the 2nd Cataract (© M. Dalton)

9.6.3.iv. Maxillary sinusitis and dental disease

Independent from poor air quality, maxillary sinusitis can also be caused by dental disease in the maxillary teeth (Mehra & Jeong, 2009). Secondary infection of sinuses can occur in severe periodontal disease and periapical lesions if the infection spreads to the floor of the sinus. However, an odontogenic origin of sinusitis appears to be relatively uncommon (10–12% of cases) due to the fact that infection of the dental structures only rarely penetrates the relatively thick cortical bone comprising the sinus floor (Mehra & Jeong, 2009). In human remains, differentiating between an environmental and odontogenic origin is usually not possible unless a clear perforation of the sinus floor caused by a periapical lesion is seen (Roberts, 2007). In addition, the two aetiologies are by no means exclusive and over the course of a lifetime people may well have suffered from both. In the people from Amara West, a high percentage of the individuals with new bone formation in the maxillary sinuses also suffered from antemortem tooth loss or periapical lesions in the upper dentition (see Table 9.12). However, in only two individuals (one New Kingdom, one post-New Kingdom) was perforation of the sinus floor observed. Therefore, an odontogenic origin for the observed examples of NBF in the maxillary sinuses cannot be excluded, but without any clear indications this remains unproven.

Dental disease		**NK**	**post-NK**
Absent	n	5	3
	%	31,3%	10,0%
Present	n	11	27
	%	68,8%	90,0%
Total	**N**	**16**	**30**

Table 9.12 Prevalence of dental disease in individuals affected by maxillary sinus (n=number individuals affected/not affected, N=number of all individuals with NBF in the maxillary sinus)

9.6.3.v. Diachronic trends in respiratory disease prevalence

Exploring temporal trends in the overall prevalence of respiratory diseases shows that both inflammatory conditions of both the lungs (rib lesions) and maxillary sinuses are relatively high throughout the entire time span of use of Amara West. However, some temporal trends could be observed. When comparing prevalence rates of NBF on the ribs in different age categories, a significant rise during the post-New Kingdom period was observed in young adults. This indicates a much earlier onset of chronic pulmonary disease and suggests a marked increase in disease/poor air quality burden.

The increase in chronic pulmonary diseases amongst people living in areas exposed to rising levels of atmospheric dust has been identified as one of the major health problems accompanying drought and desertification (Stanke *et al.*, 2013, WHO, 2013c). Several studies have shown a linear relationship between ongoing desertification, the frequency of sandstorms, and morbidity and mortality caused by respiratory infections (reviewed by Stanke *et al.*, 2013). The increasing accumulation of aeolian sand in the later occupation deposits of the town at Amara West provides ample evidence to suggest that air pollution gradually became a major health problem for people living in the area. It therefore appears reasonable to assume that these environmental changes may explain the shift in frequency of inflammatory rib lesions observed in the human skeletal remains in the later period.

Further differences were observed when analysing the prevalence of new bone formation on the ribs for each sex seperately. While in females rates were very high during the entire time of use of the cemeteries, rates in males only reached similarly high values during the post-New Kingdom period. In living Western populations, most chronic pulmonary diseases appear to affect men more commonly than women, even though this is assumed to be linked to differential exposure rather than genetic differences (Kamangar, 2013). The differences in male and female individuals during the New Kingdom period could equally be potentially explained by differences in occupation. However, the sharp rise in the post-New Kingdom male population indicates increased exposure to pulmonary pathogens/poor air quality as a result of sand in the atmosphere either brought about by changes in occupation or by changing environmental conditions. If indeed environmental air pollution through sand and dust only eventually became a health threat during the late New Kingdom and post-New Kingdom period, it would be expected to have affected everyone living at Amara West to a similar extent, regardless of sex or occupation, resulting in an even distribution of evidence of chronic inflammation of the lung throughout the entire population.

In contrast to the trends observed for diseases of the lung, evidence of maxillary sinusitis decreases significantly in the post-New Kingdom period. When controlled for by age, this distribution can be seen in all age categories. At first glance, this appears contradictory to the notion of increasing air pollution in the wake of gradual environmental deterioration as the effects on health could be expected to have similar manifestations in both the upper and lower respiratory tract. Furthermore, the findings cannot be explained by similar tendencies in dental disease frequencies because they again show a consistent increase in the post-New Kingdom period in all disease categories. However, the samples are also biased with regard to age distribution as the ratio of middle and old adults to young adults is much higher in the New Kingdom than in the post-New Kingdom groups. The prevalence of maxillary sinusitis has been shown to increase significantly with age (Merrett & Pfeiffer, 2000), and therefore the uneven age-composition of the samples could at least partially explain the large diachronic difference. When comparing only young adult individuals, the number of affected New Kingdom individuals is still higher. However, despite the small sample size it remains questionable as to what extent this difference is representative of shifts in environmental conditions or exposure to risk factors leading to maxillary sinus infections. When comparing differences between female and male individuals, a higher prevalence in females could be detected in both time periods. This corresponds to findings from the majority of other studies of skeletal remains from archaeological sites but also clinical observations (Merrett & Pfeiffer, 2000, Roberts, 2007). Similar to observations in studies on modern populations using open fires indoors (e.g. Pakistan: Colbeck *et al.*, 2010, see Figure 9.19 for a local comparison), this is usually explained by behavioural differences such the female's proximity to fire during cooking (Merrett & Pfeiffer, 2000).

Figure 9.19 Windowless kitchen in a traditional Nubian house

9.6.4. Pathological changes on the endocranial surface of the skull

Pathologically induced bone changes on the endocranial surface of the skull vault (new bone deposition, porosity, vessel impressions) represent another common sign of disease in the population from Amara West, observed in many individuals. In children, endocranial changes are relatively well researched in palaeopathology and are assumed to result from inflammatory conditions of the meningeal vessels (meningitis) which stimulate new bone formation and deepened vessel impressions (e.g. Schultz, 2001, Lewis, 2004) even though clinical data to support these assumptions are rare (Schultz, 1993). Diseases associated with endocranial lesions in sub-adult remains include primary or secondary chronic meningitis, usually caused by bacterial and viral infections including gastroenteritis, pneumonia, tuberculosis and measles, as well as other diseases such as scurvy, cancer, and finally trauma (Greenlee, 2013a, b). However, the relationship between endocranial changes and these diseases has not yet been firmly established from a clinical perspective. The possible disease spectrum that the environment at Amara West could have supported has already been discussed above (see Section 9.2). Therefore, all of the named causes of chronic meningeal inflammation would serve as reasonable explanations for the observed changes on the skull vault. A differential diagnosis again would only be possible if further diagnostic criteria were present or if additional biomolecular techniques could be applied. However, as this is not the case for the individuals of Amara West and a biomolecular analysis has not been undertaken, the skeletal changes can only be taken as another piece of evidence for a heavy disease burden in the Amara West region at the beginning of the 1st millennium BC.

With the exception of scurvy, the underlying causes are largely assumed to be similar in adults (Hershkovitz *et al.*, 2002). Hershkovitz and co-workers (2002), as well as earlier works by Mensforth *et al.* (1978), particularly emphasized the role of chronic pulmonary infections including TB as the most probable cause of the observed endocranial lesions based on studies of documented historical collection of human skeletal remains. Table 9.13 shows that endocranial changes at Amara West were highly correlated with NBF on the inner side of the ribs both in adults and sub-adults. In the absence of clear differential diagnostic features, it remains unclear whether the changes observed in the ribs of the Amara West individuals are at least partially due to TB (see 9.6.3.iii) but it nevertheless remains an intriguing thought. Comparing prevalence rates between New Kingdom and post-New kingdom individuals, some trends were evident in the adult populations too. Even though generally slightly lower rates were found than in the post-New Kingdom sub-adults, endocranial lesions were also common in the adult individuals. During the New Kingdom period, frequencies were considerably higher in young adults. However, as the sizes of the New Kingdom age sub-samples are relatively small, it remains unclear as to what extent this lower rate in the New Kingdom is real. As for the total adult population, a slight increase was observable in the post-New Kingdom population which, again, may be explained both by changes in exposure to pathogens and/or a compromised immune system due to increasing "environmental pressure".

		No rib NBF	Rib NBF	Total
New Kingdom	**n**	3	6	9
	%	33.3	66.7	
Post-New Kingdom	**n**	14	22	36
	%	39.9	61.1	

Table 9.13 Prevalence of NBF in the ribs in individuals with endocranial changes (only individuals with ribs and cranial vaults preserved, adults and sub-adults pooled)

9.7. Diseases of the joints

9.7.1. General remarks

The systematic analysis of skeletal evidence of degenerative joint diseases included osteoarthritis and intervertebral disc disease (IVD). In the major post-cranial joint complexes the analysis revealed generally high prevalence rates of osteoarthritis both in New Kingdom and post-New Kingdom individuals. In populations today, osteoarthritis represents the single most common form of joint disease worldwide (Symmons *et al.*, 2000, Zhang & Jordan, 2010). The aetiologies of both osteoarthritis and IVD are multifactorial, and include sex, obesity and hereditary factors but, most importantly, repetitive and intensive movement (Waldron, 2009: 28; 42). Both osteoarthritis and IVD represent degenerative processes, and therefore their occurrence is also clearly influenced by increasing age (Adams & Roughley, 2006b, Weiss & Jurmain, 2007, Waldron, 2009: 31). In modern epidemiological studies in Western societies, osteoarthritis is rarely seen before the 5th decade of life (Waldron, 2009: 31). However, at Amara West both osteoarthritis and IVD were already common problems in young adult individuals, with osteoarthritis affecting up to 64.3% (acromio-clavicular joint) of the total sample and IVD occurring in spines of 87.5%

(New Kingdom) and 74.2% (post-New Kingdom) individuals, respectively. These findings strongly suggest that the people living at Amara West both during the New Kingdom and post-New Kingdom periods were exposed to risk factors predisposing to osteoarthritis. In the following sections, the most commonly affected joints will briefly be discussed with regard to their aetiology and prevalence in modern and archaeological populations in comparison to the findings from Amara West (see Table 9.14). A contextualised discussion, trying to explore reasons for the observed prevalence rates, is undertaken for all joints combined in Section 9.7.2..

	Amara West NK	Amara West post-NK	Tombos[1]	Kulubnarti[2]		Gabati Meroitic[3]		Gabati Post-Meroitic[3]	
				F	M	F	M	F	M
TMJ	50.0	58.3	-	17.4		-	-	-	-
ACJ	60.0	73.1	-		35	-	-	-	-
Shoulder	5.9	37.1	10.0	25	18.3	26.3*	51.7*	19.4	57.1
Elbow	34.8	51.4	1.0	1.5	5.7	21.2	37.0	5.6	28.6
Wrist	47.4	39.3	1.0	-	-	38.6	56.1	25.0	46.4
Hand	63.2	63.6	-	32.7	26.7	36.8	44.6	53.8	25.0
Hip	41.2	41.5	6.0	28.9	17.3	50.5	43.8	27.8	42.9
Knee	31.6	54.8	1.0	31.3	20.4	19.6	29.2	13.9	17.9
Ankle	14.3	29.4	-	-		24.3	45.2	22.2	46.6
Foot	43.8	45.5	-	-	-	31.4	47.9	5.6	46.6

Table 9.14 Overview of osteoarthritis prevalence rates (individuals affected versus individuals with joints preserved) at Amara West and other comparative sites (data in %, [1]Schrader, 2012, [2]Kilgore, 1984, [3]Judd, 2012)

9.7.1.i. Extra-spinal sites

The most frequently affect joint in both groups from Amara West was the acromio-clavicular joint (ACJ). Together with the shoulder joint, it allows for any movement of the arms (Gray, 1918; 2000). The gleno-humeral joint in contrast was by far less often affected than the ACJ and amongst those joints least commonly affected. This corresponds to clinical studies where the glenoid cavity and humeral head are generally uncommon sites for osteoarthritis (Nakagawa *et al.*, 1999, Millett *et al.*, 2008). Aside from sex, increasing age and hereditary factors, risk factors include heavy lifting and over-head activities such as throwing, chopping or lifting objects overhead (Millett *et al.*, 2008). In bioarchaeological studies, the shoulder joint is usually also found to be amongst the lesser affected joints, even though comparability of osteoarthritis studies is generally problematic due to discrepancies in recording methods. The frequency at New Kingdom Tombos was very low at only 11% of analysed individuals (Schrader, 2012), similar to only 5.9% in the contemporary group at Amara West. In contrast, at the medieval Sudanese site of Kulubnarti moderate to severe gleno-humeral joint osteoarthritis was more common (Kilgore, 1984:115–116), affecting 18% of males and 25% of females, even though this is still somewhat lower than at post-New Kingdom Amara West (37.7%). Comparative data for the ACJ is somewhat limited due to the practice in bioarchaeology of presenting data pooled for the ACJ and gleno-humeral joints (Bridges, 1991) or the omission of analysis of the involvement of the ACJ at all (Schrader, 2012). High levels of bilateral ACJ osteoarthritis (38% of observed individuals) were found in males in the classic study of Merbs (1983) on Inuit populations; this was attributed to habitual kayaking. Therefore, the rates seen in the groups at Amara West, particularly those of the New Kingdom group, indicate a high level of risk that could have led to osteoarthritis in the joint complexes of the shoulder. That high mechanical demands were at least partially responsible for these values is supported by a considerable prevalence of rotator cuff disease (RCD). RCD is mainly caused by overuse of the joint, particularly in activities involving repetitive lifting, pulling, pushing and throwing (Waldron, 2009).

Elbow osteoarthritis also affected a large proportion of the New Kingdom and post-New Kingdom population of Amara West. Even though its aetiology is still under debate, elbow osteoarthritis has also been found to be high correlated with heavy manual labour in modern clinical studies conducted in the US (Stanley, 1994). It is generally rather rare today (Gramstad & Galatz, 2006) even though, given that it does not usually cause clinical symptoms, its prevalence in modern populations might be underestimated (Debono *et al.*, 2004). In archaeological populations, systematic studies often reveal high frequencies of osteoarthritis in this joint (Jurmain, 1999: 125), even though at Kulubnarti, for example, prevalence was exceedingly low with only 5% of individuals showing evidence (Kilgore, 1984: 115–116). Higher prevalence rates in women in a Native American sample have further been attributed to grinding of maize (Larsen, 1997: 174).

The joints of the hands were the second most frequently affected anatomical region in the individuals from Amara West. According to modern clincial studies the hand, together with the knee and hip, are by far the most commonly affected sites for osteoarthritis in Western populations (Kalichman & Hernández-Molina, 2010). Prevalence has been found to be generally high in occupations involving heavy manual labour (Rossignol *et al.*, 2005), in farm workers (Schmid *et al.*, 1999). Some studies have also found an association with more specialised occupations such as textile working even though this has not been supported by others (Hammer *et al.*, 2014). Other studies have shown the association between grip strength ascribed to physical labour and high levels of hand osteoarthritis (Chaisson *et al.*, 1999, Cvijetic *et al.*, 2004). Therefore, the high prevalence of degenerative changes in the joints of the hands provides another indication that physically demanding activities were likely a major part of daily life at Amara West.

Similar to observations in modern epidemiological studies, the prevalence of osteoarthritis in the hip and knee joints was also very high in both New Kingdom and post-New Kingdom individuals. These joint complexes represent the major weight-bearing joints in the body. osteoarthritis in these joints has been linked to increasing age, genetic background, obesity and sex, with women being more commonly affected than men (Waldron, 2009: 38). The precise contribution of work load on the development of hip osteoarthritis is still not clear but has only been found to be moderate in a large-scale clinical meta-study (Lievense *et al.*, 2001). Heavy lifting has been identified as the most important occupational hazard putting people at risk of OA in the hip (Sulsky *et al.*, 2012). Together with osteoarthritis of the hand and knee, it is frequently cited as one of the most common farming related joint diseases (Croft *et al.*, 1992, Jurmain, 1999: 89).

The lowest prevalence rates of osteoarthritis were observed in the joints of the ankle bones. This is generally in accordance with observations in modern as well as archaeological populations which have found osteoarthritis in the ankle to be generally very uncommon. This has been attributed to biomechanical differences in contrast to other joints with higher susceptibility, the thickness of the joint cartilage (Huch *et al.*, 1997). The generally low frequency of osteoarthritis in the ankle may further derive from evolutionary changes and may be linked to the fact that in contrast to the knee or hip joint, the changes occurring in loading during evolution of erect posture were a lot less drastic in the ankle joint. Similar trends in the prevalence of ankle osteoarthritis are reported in bioarchaeological studies (Bridges, 1991) even though the ankle joint is only rarely observed for osteoarthritis and therefore comparative data is limited.

9.7.1.ii. Synovial joints of the spine and IVD

Degenerative changes in the synovial joints and bodies were equally common in both chronological groups at Amara West. The aetiology of osteoarthritis in the spine, as well as the underlying biomechanical reasons for its spatial distribution among the different joints, are still poorly understood because osteoarthritis of the spine has received far less attention than other anatomical sites. However, it is suspected to be similarly determined by age, sex, obesity, and genetic background, as well as activity (Gellhorn *et al.*, 2013). Experimental forensic based research has examined the roles of different underlying mechanisms, but concluded that it remains unclear whether osteoarthritis in the intervertebral joint facets results from excessive movement or load-bearing, or a combination of both (Brown *et al.*, 2008). With regard to distribution of osteoarthritis in joints within the spine, both modern and bioarchaeological studies consistently report the highest involvement being in the lumbar spine, while the thoracic spine appears to be the least commonly affected area (Bridges, 1994, Jurmain, 1999: 116–117, Waldron, 2009: 35, Gellhorn *et al.*, 2013). This pattern deviates from what has been observed at Amara West because, even though lumbar involvement had the highest frequency in the age-pooled New Kingdom group (with a much smaller sample size), in the post-New Kingdom period, the thoracic spine was more often affected. These trends are also observable when broken down into age categories, even though due to small sample sizes the data are somewhat limited.

Despite the development of IVD equally being governed by multiple factors including sex, age, and particularly genetic background (Adams & Roughley, 2006b, Chan *et al.*, 2006), its prevalence and distribution within the spine has been shown to increase significantly with high levels of physical activity in clinical studies (O'Neill *et al.*, 1999). The lumbar spine is usually the most commonly affected area both in modern Western (Weiler *et al.*, 2012) and archaeological populations (Waldron, 2009: 43), as seen for osteoarthritis of the spine. Based on the outcome of several studies it is comprehensively agreed that this predominance is largely related to load bearing even though genetic factors also have to be taken into account (Weiler *et al.*, 2012). The epidemiological factors and mechanisms governing the development of IVD in other parts of the spine are not yet fully understood (Weiler *et al.*, 2012), and therefore the scope for interpretation of the spatial pattern observed at Amara West is very limited. It nevertheless appears notable that, in contrast to the majority of bioarchaeological studies (Jurmain, 1999: 117–118), the cervical spine is the most commonly affected section (see 9.7.2.ii). Nevertheless, regardless of the distribution pattern, the most significant outcome of the analysis of vertebral osteoarthritis and IVD lies in the fact that it was already present in a high percentage of young adult individuals both during the New Kingdom and post-New Kingdom period. As both diseases are progressive in nature and increasing age represents one of the most important risk factors (Weiler *et al.*, 2012, Gellhorn *et al.*, 2013), this does indicate a high level of exposure to risk factors leading to degenerative diseases of the spine.

9.7.2. Degenerative joint diseases and activity at Amara West

9.7.2.i. General patterns

Inferring specific activities from the levels and distribution of osteoarthritis and other degenerative joint diseases has long been a popular topic in bioarchaeological research and the palaeopathological literature holds numerous examples (e.g. Bridges, 1991, and reviews by Larsen, 1997: 167–185, Roberts & Manchester, 2005: 147–150, Schrader, 2012). Such endeavours are now considered problematic due to the multifactorial aetiology of all the joint lesions, including genetic and dietary factors in addition to biomechanical stress (Weiss & Jurmain, 2007). In addition, both clinical and palaeopathological studies have failed to reveal any clear relationship between modes of subsistence and patterns of osteoarthritis (Bridges, 1992, Jurmain, 1999: 127). Another factor limiting the potential of occupational inferences drawn from modern clinical studies is related to the ethnic make-up of study populations. Hereditary factors and ethnic background have also been shown to have an important influence on susceptibility to osteoarthritis. The vast majority of clinical studies have been carried out on Caucasian populations from Europe and the United States, and epidemiological data from Africa or the Middle East is only of very limited availability (Symmons *et al.*, 2000). However, within the archaeological and environmental context of Amara West, some tentative statements can nevertheless be made about modes of subsistence and potential occupationally related activities and their relationship to the observed levels of osteoarthritis, at least for the people of the New Kingdom period. Contextual data allowing for inferences is only available for the New Kingdom period as intact settlement layers dating to the post-New Kingdom period have not yet been discovered at Amara West.

The settlement was situated on a small island in a relatively remote setting. Little is yet known about contemporary settlement activity in the region but, with the exception of the larger town at Sai, 5kms upstream of Amara West, there is little to suggest high population density in the area. The large number of magazines and storerooms within the settlement during Phase IA and IB (c. 1300–1200BC) indicates commodity storage at Amara West; delivery notes upon ostraca provide evidence that some of this storage was part of an organised redistributive network.. However, it remains questionable as to how far these benefited the local population, or rather were part of the wider colonial network of trade and tributes. Therefore, in order to sustain a population at Amara West, relative economic independence would have been inevitable in order to guarantee long term survival of the community. The changing character of the settlement towards a more self-organised entity from *c.* 1200BC onwards (Spencer, 2014c) provides archaeological support for this claim. Even though no direct evidence has been found to date, the terrain would have certainly allowed for agriculture to be practised. Areas unoccupied by houses which would have been suitable for cultivation and keeping of livestock can be found in the lower lying parts of the island to the west and north-west of the walled town, some of it subject to annual inundation (Spencer, 1997).

Fishing, evidenced through finds of fishing weights in several houses at Amara West (Spencer, 2014a) may have had a certain economic importance too, even though the scale and importance of fishing in terms of subsistence awaits the study of the fish bones from the site. Occupationally related activities of daily life would have comprised all tasks necessary for food production and processing, and maintenance of houses (see Figure 9.20) and agricultural land. In addition, small scale industrial activities such as metalworking, production of pottery (see Figure 9.21), and possibly faience, are indicated by finds of workshop areas and kilns within the settlement (Spencer, 2014a, b). Processing of quartz to extract gold has long been suggested as one of principal activities at Amara West, stone tools found in an extramural house during the 2014 season bore gold traces (Spencer, pers. comm., 2014). Based on the size of the houses and settlement it can be assumed that the population was relatively small throughout the time period of occupation (Spencer, 2014a) and would have perhaps not allowed for a high degree of division of labour or craft specialisations.

Figure 9.20 Building works in a mud brick house

Figure 9.21 Traditionally pottery production in a Nubian village

The association of an agricultural lifestyle with high levels of osteoarthritis, assumed to be caused by occupationally related activities involving a high degree of biomechanical stress, has received major attention in bioarchaeological studies (reviews by Larsen, 1997: 169–175, Jurmain, 1999: 127–129) and can be demonstrated in both archaeological (e.g. Kilgore, 1984, Bridges, 1991, Larsen, 1997: 167–185) and modern clinical studies in populations worldwide (e.g. Jones, 1990, Walker-Bone & Palmer, 2002, Kirkhorn *et al.*, 2003, Vitale *et al.*, 2006, Davis & Kotowski, 2007). However, patterns appear to vary between different agricultural populations, presumably indicating the fact that mechanical loading is not the only underlying cause of osteoarthritis (e.g. Bridges, 1991, Jurmain & Kilgore, 1995, Weiss & Jurmain, 2007). Nevertheless, some trends do seem to be common to both historic and modern agricultural groups and communities. Particularly high rates of osteoarthritis in the hips, knees and lower spines of farmers and farm workers have been noted in several clinical studies (Walker-Bone & Palmer, 2002). Despite the problems associated with inferring specific activities from patterns of osteoarthritis, the high levels of osteoarthritis observed in the extra-spinal joints, IVD and associated activity-related conditions such as RCD, clearly show that there was a high level of risk factors causing osteoarthritis for the people who were buried at Amara West. This is further highlighted by the fact that at Amara West high frequencies of osteoarthritis in all spinal and non-spinal joints already affected young adult individuals, even though modern clinical data suggests degenerative joint diseases to be uncommon in individuals under 40 years (Waldron, 2009: 31). Based on the archaeological context, a high degree of biomechanically demanding activities associated with an agricultural lifestyle certainly appears a reasonable suggestion for the people who lived during the New Kingdom at Amara West, and this provides a good explanation for the observed prevalence of osteoarthritis in the joints and spine.

Contextualising the results for the post-New Kingdom individuals is more difficult in the absence of preserved architecture or occupation deposits dating to the post-New Kingdom period. In most of the extra-spinal joint complexes an increase in prevalence rates is seen during the post-New Kingdom period, even though only in the shoulder joint was the increase statistically significant. In the spine, post-New Kingdom values of osteoarthritis and IVD slightly decrease (statistically significant in young adult cervical vertebrae), which may indicate certain changes in activity patterns associated with occupations, even though in the light of the smaller sample size any such claims have to remain tentative. Even though it is not yet known where or how people at Amara West lived during the post-New Kingdom period, continued use of the cemeteries and graves within, without changes in material culture, suggests continued settlement in the area. However, deteriorating climatic conditions would have made cultivation increasingly difficult. In the light of evidence for climate change today, intensification of agriculture is a common strategy in areas faced with aridification (Millennium Ecosystems Assessment, 2005). A decline in floods and water supply, together with additional loss of water through increased evaporation, would have demanded an increasing amount of labour to safeguard agricultural productivity. Further consequences are increased growth of weeds, decreased availability of organic matter to allow for effective fertilising but also animal fodder (IISD, 2013). Architectural evidence from the New Kingdom settlement suggests that maintenance of the houses may have become increasingly laborious as living spaces had to be adapted to withstand influxes of sand. However, whatever the underlying mechanisms, bioarchaeological evidence points towards increasing biomechanical demands on the settlement's population towards the final stages of occupation at Amara West.

Sex-based comparisons of osteoarthritis have also been used to detect occupational differences between men and women (reviews by Bridges, 1992, Larsen, 1997: 176–178). The sex-related comparison of the individuals from Amara West only revealed a few major differences between male and female individuals. In the spine, significant diachronic differences were observed in the prevalence of IVD in the lumbar region between New Kingdom and post-New Kingdom females as well as between males and females in the New Kingdom period. Even though the sample size in the New Kingdom individuals is admittedly small, this difference is worth consideration. In addition, post-New Kingdom men displayed a markedly higher prevalence of osteoarthritis in the cervical vertebrae than females.

A strong gender-based division of work in Pharaonic Egypt is well evidenced through textual and iconographic evidence from the Old Kingdom onwards. These sources convey the impression that men were mainly involved in physical labour, outdoors while women's work was mainly confined to work inside or near the house (Sabbahy, 2012), even though this appears to be a somewhat idealised concept. Similar evidence from ancient Nubia is missing even though it appears very likely that gender-based differences in occupation were equally in place, as is still common practice in Nubian villages today (Jennings, 1995; observations by the author). Contrary to ideals conveyed by Egyptian sources such as tomb scenes and texts, even though there are differences in types of occupation, men and women are equally involved in physically demanding activities surrounding the maintenance of agricultural land, livestock and houses. The skeletal evidence supports the claim that women in the ancient settlement at Amara West indeed carried out physical work. Only a small number of notable differences in the patterns of osteoarthritis could be observed between males and females. However, in the absence of post-New Kingdom contextual data as well as the small sample size in the New Kingdom sample, any more detailed inferences about occupational differences would be highly speculative and will therefore be omitted.

9.7.2.ii. Osteoarthritis and IVD in the cervical spine

IVD was highest in frequency in the cervical spine, a difference that was most distinctive in young adult individuals. This trend affected both men and women, even though rates were slightly higher in men than in women. This finding stands in contrast with most bioarchaeological and clinical studies which usually report higher frequencies of both osteoarthritis and IVD in the thoracic and lumbar region. Higher values of degenerative joint disease in the cervical spine, however, has been reported in several archaeological populations from different

Figure 9.22 Local woman carrying animal fodder (© A. Garnett)

geographical contexts and it has been hypothesized that this reflects the practice of habitually carrying heavy loads on the head (Bridges, 1994, Lovell, 1994, Sofaer Derevenski, 2000). An association between this practice and vertebral disc degeneration in the spine has also been noted by a number of clinical studies in African and Asian groups (Jäger *et al.*, 1997, e.g. Echarri & Forriol, 2002, ; reviewed by Porter *et al.*, 2013). The habit of transporting heavy loads on the head is well known for Nubian men and women from iconographical evidence in the past but also in Sudan today (see Figure 9.22). Therefore it could have potentially contributed to the high levels of cervical IVD observed in both chronological groups from Amara West.

9.7.2.iii. Osteoarthritis in the temporo-mandibular joint

Osteoarthritis in the temporo-mandibular joint (TMJ) was also a very common finding at Amara West, with no major differences occurring between the New Kingdom and post-New Kingdom samples. A high prevalence was already observable in the young adult group even though, with one exception, the group is exclusively comprised of post-New Kingdom individuals. Similarly high frequencies of TMJ osteoarthritis were noted by Strouhal & Jungwirth (1984) in their analysis of the human remains from the C-Group and Pan-Grave series. They attributed their findings to the coarse diet which was also attested by the high degree of dental attrition. The link between attrition and TMJ osteoarthritis was also noted by Merbs (1983) and Hodges (1991). In addition, Merbs attributed the high degree of TMJ osteoarthritis to habitual reasons because females used their anterior teeth to hold hides with their teeth while stretching and softening them for clothing (Merbs, 1983). The high degree of dental attrition (see Section 8.5.2) in individuals from both time periods has already been discussed in detail (see Section 9.4.1) and likely serves as an explanation for the high frequencies of TMJ osteoarthritis in the Amara West individuals too. Whether teeth were also used as tools at Amara West cannot be supported with certainty given that attrition was consistently high throughout the dention.

As a final note, looking at distribution patterns of joint diseases within individual skeletons may aide gaining a better understanding of the underlying aetiologies. Coupled with other indicators of disease such rib lesions or trauma, this may allow for identification of more specific occupations, or craft specialisation. Set against the socio-cultural, environmental and archaeological background, individual osteobiographies (Saul, 1972, Stodder & Palkovich, 2012) could be created in order to shed further light on life at ancient Amara West. However, this approach lay beyond the scope of this thesis and will have to await future research.

9.7.3. Gout

Gout is metabolic disease caused by a disturbance to the metabolism of purine which leads to increased storage or decreased excretion of uric acid (Ortner, 2003: 583). Its precise aetiology remains unclear but the main precipitants include genetic factors as well as dietary habits (Choi *et al.*, 2005). A high consumption of meat and fish, as well as alcohol, has been identified to significantly increase the risk of developing gout (Choi *et al.*, 2005). Its modern prevalence ranges from around 1% in Western populations to as high as 35% in some Asian populations, presumably as a result of genetic predisposition (Chen & Schumacher, 2008). Skeletal changes of gout arise from precipitation of urate crystals within or around the joints. The accumulation of these crystals (tophi) cause discrete, circular asymmetrical erosions in articular or periarticular bone tissue, with overhanging margins which may be accompanied by sclerotic margins, even though the exact process leading to bone lesions is still under debate (Dalbeth *et al.*, 2009). Joint involvement can affect one or multiple joints, and the most commonly affected sites are the hands, feet, ankles and wrists (Rogers, 2000: 172–174, Waldron, 2009: 69). The most distinctive changes usually occur in the distal end of the first metatarsal (e.g. Ortner, 2003: 584, Dalbeth *et al.*, 2009). Under favourable soil conditions the survival of urate crystal deposits is also possible and allows for a conclusive diagnosis of gout (Swinson *et al.*, 2010). Despite evidence from ancient Greek medical texts attesting to the antiquity of the disease, it is relatively rarely diagnosed in human remains (Roberts & Manchester, 2005: 162), and one of the earliest reported examples is in a male Egyptian mummy analysed by Smith & Dawson (1924).

Three individuals from Amara West presented small, circular, sharply demarcated extra-articular erosions on the 1st metatarsal (dorsal), and the lateral or medial sides of tarsals (os naviculare, os cuboideum, ossa cuneiforme). Radiographic examination of the os naviculare and os cuneiforme laterale of one individual showed a slight sclerotic margin, even though the changes are by no means as pronounced as the more unambiguous lesions reported by other researchers (Rogers, 2000, Ortner, 2003: 584). One differential diagnostic option that has to be taken into account is rheumatoid arthritis (Aufderheide & Rodríguez-Martín, 1998: 111). This inflammatory disease of the joints affects the small joints of the hands and feet but can also occur in the wrists, elbows, ankles, ACJ and spinal joints. The disease process starts in the synovial membrane of the joint and in advanced stages leads to erosion of the joint cartilage and underlying bone on the joint surfaces, along with involvement of the joint margins and in periarticular locations (Waldron, 2009: 49–53). The skeletal changes caused by rheumatoid arthritis are characteristically manifested as small circular erosions with a "scooped" floor, undercutting edges and sharp or scalloped ridges which always occur bilaterally. In the individuals from Amara West, the hands and feet were not affected, the distribution of the lesions was asymmetric, and the lesions were exclusively extra-articular; a diagnosis of rheumatoid arthritis appears rather unlikely. In addition, even though rheumatoid arthritis is increasingly prevalent in African populations (McGill, 1991), the antiquity of rheumatoid arthritis is still unknown. So far no unambiguous evidence has been identified prior to the 1st millennium AD, providing support for the conclusion that rheumatoid arthritis is a modern disease (Waldron, 2009, Entezami *et al.*, 2011).

The small, erosive lesions observed in the individuals from Amara West are not as distinctive as the skeletal changes usually observed in human remains, and therefore a firm diagnosis cannot be made. Nevertheless, their macroscopic appearance is consistent with a diagnosis of gout. Underlying causes and environmental risk factors leading to gout, such as a diet high in meat, would have certainly been present at Amara West. It is also interesting to note that all individuals with potential evidence of gout come from the same grave. Even though it remains unproven in the case of Amara West, chamber tombs were commonly used for families in ancient Egypt (Grajetzki, 2003). Gout has clearly been proven to have a strong genetic predisposition (Choi *et al.*, 2010), and therefore this might provide further support for an identification of the observed changes as gout.

9.7.4. Ankylosing spondylitis

Ankylosing spondylitis (AS) is a systemic, progressive, non-infectious inflammatory spondylarthropathy which affects the connective tissue and results in extensive calcification of tendons and ligaments (Aufderheide & Rodríguez-Martín, 1998: 102). It primarily affects the sacro-iliac joints and spine, even though calcifications can also occur in the major peripheral joints (Aufderheide & Rodríguez-Martín, 1998: 102, Waldron, 2009: 58–60). AS represents the most common form of spondylarthropathy and affects between 0.1 and 1% of the world's population, with prevalence being highest in white males and lowest in sub-Saharan Africa (Brent, 2013). Its aetiology is still unknown, but it is now considered an autoimmune disease triggered by a combination of genetic and environmental factors (Zambrano-Zaragoza *et al.*, 2013). New research has established that 5–10% of people with AS have associated inflammatory bowel disease, either Crohn's disease or ulcerative colitis (Rudwaleit & Baeten, 2006). The onset of the disease usually occurs before the age of 45 and it predominantly affects males (Sieper *et al.*, 2006). Due to the fact that the extensive calcification of the spine and sacro-iliac joint usually allows for a relatively easy diagnosis, numerous examples have been reported in the palaeopathological literature. This also includes several from ancient Egypt, with the oldest dating back to around 1900BC (reviewed by Bourke, 1967: 357–360).

Calcification of the vertebral column can also occur in a number of other spondyloarthropathies, including reactive spondyloarthropathy (Reiter's Syndrome) and psoriasis (Waldron, 2009: 60–66). The main differential diagnostic features of these conditions are the presence of erosive changes in the bones of the hands and feet and the presence of "skip" lesions, i.e. the sparing of segments of the spine. Sacro-iliac fusion is present in Reiter's Syndrome but not necessarily in psoriatic arthropathy. In the male individual from Amara West, the hand and foot bones did not display any changes, the sacro-iliac joints were fused on both sides and extensive ankylosis affected the vertebral bodies, most of the inter-vertebral joints, and the costo-clavicular joints. Therefore, it seems reasonable to suggest the skeletal changes observed in Sk238 are likely to result from AS.

9.7.5. Diffuse idiopathic skeletal hyperostosis (DISH)

One New Kingdom male (Sk301-4) displayed extensive calcifications of the spine which, in contrast to Sk238, only affected the right side of the vertebral column. Skeletal changes such as these can be caused by DISH (Waldron, 2009: 73), a condition of unknown aetiology, although some clinical studies have suggested a relationship to Type II diabetes, obesity and genetic susceptibility (e.g. Rogers & Waldron, 2001, Van der Merwe *et al.*, 2012). The hallmark feature of DISH is calcification of the anterior longitudinal ligament. Further diagnostic features, allowing for a differentiation from AS, include sparing of the intervertebral disc spaces as well as intervertebral joints. Calcification can further affect the extra-spinal ligamentuous and muscle attachment sites, particularly the ischial tuberosity, iliac crest and Achilles tendon (Aufderheide & Rodríguez-Martín, 1998: 97–98). With regard to epidemiologic profile, it is well established that it affects predominantly males and is generally first diagnosed in people aged over 40 years (Belanger & Rowe, 2001, Van der Merwe *et al.*, 2012). DISH is relatively well evidenced in the palaeopathological record (e.g. Aufderheide & Rodríguez-Martín, 1998: 98–99, Rogers & Waldron, 2001, Ortner, 2003: 559–560, Van der Merwe *et al.*, 2012). Several studies have shown the disease to be particularly common in medieval monastic cemeteries, which has been attributed to the excessive lifestyle associated with medieval monasteries (Rogers & Waldron, 2001). However, recent biomolecular research has revealed evidence that DISH is significantly more common in people, monastic and non-monastic, consuming a diet high in animal protein (Spencer, 2008). In ancient Egypt evidence is rare but was, for example, tentatively identified in the mummy of Ramesses II (Chhem *et al.*, 2004).

The calcifications seen in this man from Amara West fulfil all of the diagnostic criteria associated with DISH. Spinal calcifications consistent with the location of the anterior longitudinal ligament occurred only on the right side of the vertebral bodies between Th3 and Th7, as well between Th8 and Th12. Ossification of ligaments was further observed in several costo-vertebral joints, together with entheseal changes in the patella, calcaneus and iliac crest. The vertebral endplates were not affected and narrowing of the intervertebral spaces was not observed, which argues against a diagnosis of AS. Based on the large amount of animal bones present in the settlement, it can be assumed that meat was certainly part of the diet at Amara West. However, due to poor preservation, analysis of stable nitrogen isotopes which could have helped clarify whether this person consumed higher amounts of meat than the remaineder of the population was not possible. It is nevertheless notable, that the Sk301-4 is clearly of elite background, indicated through his burial in a pyramid tomb in Cemetery D. Even though it is impossible to prove at this current stage, it is nevertheless intriguing to think that the higher status may have also resulted in higher meat consumption as has been suspected for ancient Egyptian populations in general (David *et al.*, 2010a).

9.8. Trauma

9.8.1. General remarks

The fractures observed in the population from Amara West will first be discussed for each anatomical location with regard to their underlying mechanism and prevalence in comparison to modern and other bioarchaeological data. An overview of total prevalence rates is provided in Table 9.15. As potential explanations and mechanisms may overlap considerably for fractures of different skeletal elements, they will then be discussed in relation to their environmental and cultural context.

		NK	post-NK
Bones affected by trauma	**n/N**	17/2623	126/9122
	%	0.6	1.4
Individuals affected by trauma	**n/N**	10/36	45/116
	%	27.8	38.8

Table 9.15 Total true and crude prevalence rates at Amara West (n=number of bones/individuals affected by trauma, N=total number of bones/individuals observed)

9.8.2. Cranial Trauma

Injuries to the skull vault were observed in one New Kingdom (4.3%) and nine post-New Kingdom individuals (12.7%). In eight out of the 10 individuals with trauma to the cranial vault, the lesions comprised small circular, oval or elongated defects of the frontal and parietal bones, ranging in size between 0.9 and 2.5cms. In all individuals, the traumatic lesions were well healed even though associated NBF surrounding the fracture was observed in six individuals, perhaps reflecting secondary inflammation of the wound, potentially through associated laceration of the skin. Changes on the endocranium resulting from associated haematoma were not observed. The aetiology of these traumatic lesions is difficult to determine and further complicated by the well healed nature of the defects. Eight of the head injuries appear to be superficial indentations of the outer table without involvement of the inner table. Displacement of the fracture fragments into the cranial cavity occurred in only one individual (Sk309-2). Depression fractures of the cranial vault are caused by blunt force trauma. Involvement of the outer table alone usually reflects low-energy trauma, while an extension into the inner table requires significant high-velocity impact (Oehmichen *et al.*, 2006: 117). A more secure identification of sharp force trauma, caused by a sharp object, could only be made for an injury to one male, a post-New Kingdom individual

(Sk218). In all other individuals, the exact aetiology of the lesions on the skull vault remains unknown. Depression fractures to the fronto-parietal region represent the most common type of cranial vault trauma in clinical studies in modern Western populations (Oehmichen *et al.*, 2006: 116). With regard to their mechanism, they are most commonly seen in road traffic accidents, falls, industrial accidents, or assaults (Oehmichen *et al.*, 2006: 116–117). In one post-New Kingdom man (Sk201-1), a fracture to the left zygomatic process of the frontal bone was observed. Fractures of this kind can result from high energy direct trauma to the orbital rim or indirectly through trauma to the soft tissue structures of the eye ("blow-out" fractures) (Rootman, 2003: 444). Today, the most common causes for fractures in this area are assaults, sport injuries or industrial accidents (Haraldson, 2013). Nasal fractures were observed in three post-New Kingdom individuals (6.5%). Injuries to the thin nasal bones are usually caused by direct blunt trauma. Modern epidemiological studies have found the impact of blunt objects, falls from varying heights, road traffic accidents, as well as interpersonal violence, to be the most common causes (Kucik *et al.*, 2004).

The results obtained from Amara West fit well within the general Sudanese context (see Figure 9.23 and Table 9.16). The biocultural implications of these findings well be discussed in more detail in Section 9.8.7

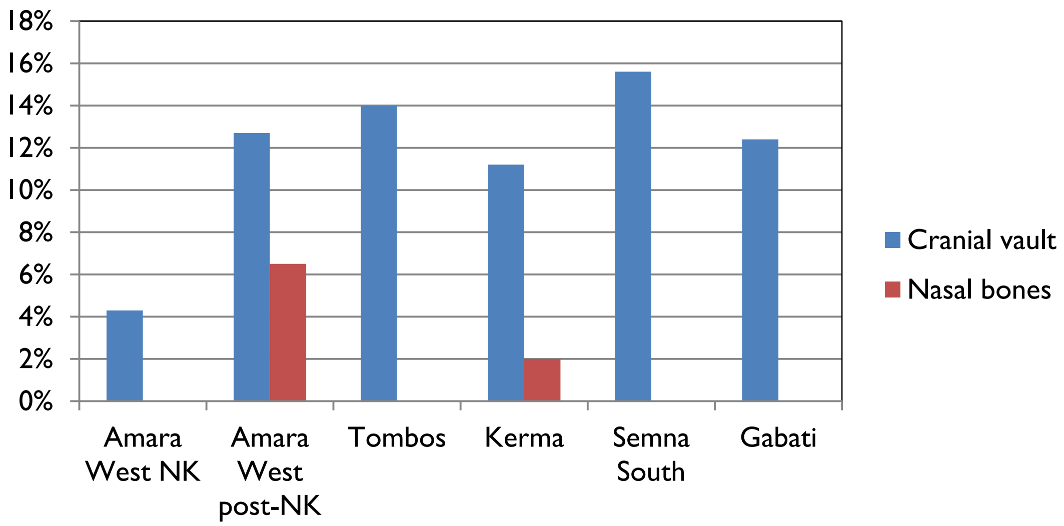

Figure 9.23 Comparison of the frequency of fractures in the skull and nasal bones between individuals from Amara West and other sites in Sudan (individuals with elements affected vs. element preserved, see Table 9.15)

		Cranial vault			Nasal		
Site	**Date**	**n**	**N**	**%**	**n**	**N**	**%**
Amara West NK	1300–1070BC	1	23	4.3	0	12	-
Amara West post-NK	1070–800BC	9	71	12.7	3	46	6.5
Tombos[1]	1500–1070BC	1	72	1.4	-	-	-
Kerma[2]	1750–1550BC	21	187	11.2	2	110	0.02
Semna South[3]	200BC–1400AD	64	396	15.6	-	-	-
Gabati[4]	200BC–1100AD	16	129	12.4	-	-	-

Table 9.16 Comparison of skull fracture prevalence at Amara West and other sites in Sudan (n=number of individuals affected, N=number of individuals observable, data sources: [1]Buzon & Richman, 2007, [2]Judd, 2004, [3]Alvrus, 1999, [4]Judd, 2012)

9.8.3. Fractures of the clavicle and long bones

The most commonly affected long bones in both time periods were the ulna and radius. With only one exception, all injuries were of the distal portion of the bone and exclusively comprised simple oblique or transverse fractures. Due to their close anatomical relationship and similar biomechanical and functional properties, the underlying mechanisms governing injuries to the distal portion of the forearm are very similar. In the majority of cases fractures occur due to a fall on the outstretched hand, causing axial compression in combination with a bending movement which leads to backwards flexion of the wrist (Resnick & Goergen, 1995: 2732). Fractures to the distal radius are amongst the most commonly observed fractures in both modern clinical studies of Western populations (Koo *et al.*, 2013) as well as archaeological studies (Roberts & Manchester, 2005: 99, Waldron, 2009: 149).

Ulna fractures are usually less frequently reported in modern Western societies. In fall-related accidents they are very often associated with fractures to the distal radius (Müller-Mai & Mielke, 2010). Out of the seven ulna fractures observed in individuals from Amara West, three occurred in association with fractures to the distal radius (see see Figure III.131), while in the additional four skeletons the radius was intact (one to the middle section, three to the distal section). Isolated fractures to the distal ulna, commonly referred to as “parry” fractures in the palaeopathological literature, usually result from direct trauma to the arm (Resnick & Goergen, 1995: 2732). In addition to lack of radial involvement, diagnostic features are a transverse or slightly oblique fracture line, swelling between the middle and distal third shaft junction and little or lack of rotation, or apposition (Resnick & Goergen, 1995: 2732). Therefore, they are often cited as a means of inferring levels of interpersonal violence in a population (e.g. Judd, 2004). However, 40% of modern cases of isolated fractures to the ulna shaft occur as a consequence of direct blunt trauma in road traffic accidents when hit by a fast moving object (Müller-Mai & Mielke, 2010: 71)

Equally common were fractures of the clavicles, an observation that again corresponds to clinical observations according to which the clavicle ranks amongst the bones most often affected by trauma (Resnick & Goergen, 1995: 2715). The mechanisms differ according to what section of the clavicle is involved. The middle third represents the most common site, followed by the lateral third. Fractures to the lateral and middle thirds of the clavicle shaft, which were observed in two individuals at Amara West, result from direct trauma to the shoulder either through falls on the shoulder or direct blows (Stanley *et al.*, 1988). Two post-New Kingdom individuals suffered fractures to the medial third of the clavicle. This is a relatively unusual fracture location in modern clinical studies in Western industrialised countries, accounting for only 5% of all clavicle fractures (Throckmorton & Kuhn, 2007). In more than 90% of all observed cases they are caused by direct trauma, mainly in relationship to road traffic accidents.

Fractures of the humerus were only observed in two post-New Kingdom individuals, affecting the proximal third of the shaft in both instances. Both fractures were similar in nature, representing oblique fractures along the surgical neck with significant lateral displacement of the shaft on healing. The main underlying fracture mechanisms includes falls on the outstretched arm with severe abduction of the shoulder, or a direct blow to the side of the upper arm (Resnick & Goergen, 1995: 2712). Fractures of this type are commonly observed in modern European and Northern-American studies accounting for 5% of all observed fractures (Frankle, 2013). They are usually seen in middle-aged and elderly people where the risk is accelerated by reduced bone density. In younger people fractures to the proximal humerus are usually associated with high-energy trauma.

Fractures of the long bones of the lower limb were confined to only one post-New Kingdom individual with a fractured proximal femur shaft (see Figure III.134). This appears particularly surprising given that in modern populations fractures of the femora, tibiae and fibulae are amongst the most common types of fractures, with the tibia being the most commonly fractured long bone of all (Resnick & Goergen, 1995: 2775) Tibia and fibula fractures result from high force, direct or indirect trauma.

Fractures of the femur, particularly in the area of the femoral neck are frequently associated with advanced osteoporosis; therefore the high prevalence in modern Western societies may partly be related to an increasing prevalence of osteoporosis worldwide (Jacobs-Kosmin, 2013). The significance of these findings will be discussed in more detail below (see 9.8.7). Transverse fractures to the proximal or middle femoral shaft are the most common type of femoral fractures, mainly occurring in relationship to direct trauma. Due to the fact that the femur is the strongest bone in the body, these fractures require significant forces and are often seen in road traffic accidents (Resnick & Goergen, 1995: 2762).

In order to evaluate the degree of fracture risk for the inhabitants of Amara West relative to other archaeological populations, the data were compared to fracture prevalence rates from published sites from different geographical and temporal backgrounds (see Figure 9.24 and Table 9.17). The overall prevalence rates of long bone fractures (excluding clavicles, for comparability) at Amara West was 0.9% for all observed long bones from the New Kingdom period, 1.8% of the post-New Kingdom period and 1.6% for the overall group. The New Kingdom value is relatively low, but may be biased by the small sample size. The inhabitants of ancient Amara West fall well within the range of other ancient Sudanese populations, with fracture rates ranging between 1.6% (Semna South) and 4.3% (Kulubnarti). With the exception of Kulubnarti and Kerma, the populations from other ancient Sudanese sites seem to have experienced similar levels of long bone fractures. Even though temporally somewhat different from Amara West, general characteristics such as a largely agricultural subsistence, and organisation in small rural communities living in mudbrick settlements along the Nile are shared by all the above cited examples. Within the population of Kulubnarti, the large number of fractures was related to the potentially hazardous rocky terrain of the 2nd Cataract (Kilgore *et al.*, 1997), whereas interpersonal violence related to political interactions between the Egyptian and the Kerman states was blamed for higher frequencies of trauma at Kerma (Judd, 2004). In contrast, people in medieval and post-medieval European urban settlements experienced markedly fewer long bone fractures.

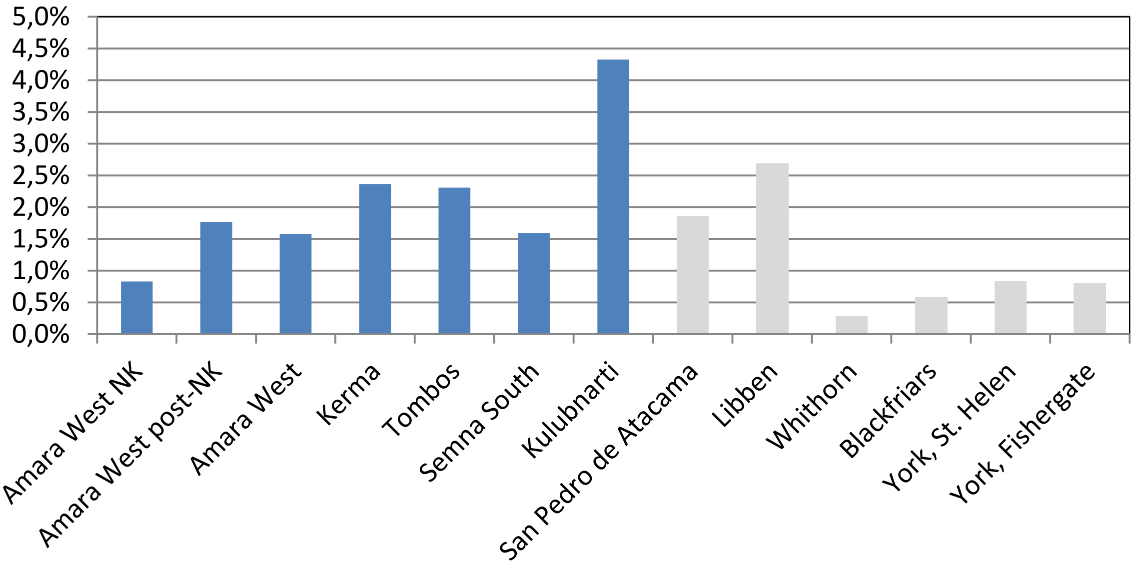

Figure 9.24 Prevalence of long bone fractures in Sudanese (blue) and other sites worldwide (grey, number of fractures versus number of elements observable, see Table 9.17)

Site	Country	Date	n	N	Prevalence
Amara West NK	Sudan	1300–1070BC	2	241	0.8%
Amara West post-NK	Sudan	1070–800BC	13	735	1.8%
Amara West	Sudan	1300–800BC	15	949	1.6%
Kerma[1]	Sudan	1750–1550BC	48	2029	2.4%
Tombos[2]	Sudan	1500–1070BC	19	823	2.3%
Semna South[3]	Sudan	200BC–1400AD	48	3013	1.6%
Kulubnarti[4]	Sudan	500–1000AD	66	1526	4.3%
San Pedro de Atacama[5]	Chile	250–1240AD	46	2471	1.9%
Libben[5]	US	800–1100AD	57	2123	2.7%
Whithorn[5]	UK	800–1200AD	27	9563	0.3%
Blackfriars[5]	UK	1246–1539AD	11	1861	0.6%
York, St. Helen-on-the-Walls[5]	UK	1100–1550AD	41	4938	0.8%
York, Fishergate[5]	UK	1200–1600AD	26	3235	0.8%

Table 9.17 Prevalence of long bone fractures in different archaeological population in Sudan and worldwide (n=number of fractures, N=number of elements bones observable, sources: [1] Judd, 2004, [2] Buzon & Richman, 2007, [3] Alvrus, 1999, [4] Kilgore, 1997, [5] Roberts & Manchester, 2010: 98, 99)

When comparing the fracture pattern for individual long bones between Amara West and populations from other archaeological sites, several trends could be observed (see Figure 9.25 and Table 9.18). The radius and ulna are generally the most commonly affected long bones in all populations, as indicated above, and fracture prevalence in the individuals from Amara West rank among the highest for the clavicle, humerus and radius.

Fractures of the ulna were more frequent at Kerma and Semna South. In both samples, the high prevalence was explained by a high degree of interpersonal violence in the wake of Egyptian colonialism and subsistence stress (Alvrus, 1999, Judd, 2004). Fractures of the lower limb bones were generally less often seen than fractures in the upper limb, even though Amara West represents the only site where fractures of this kind were absent.

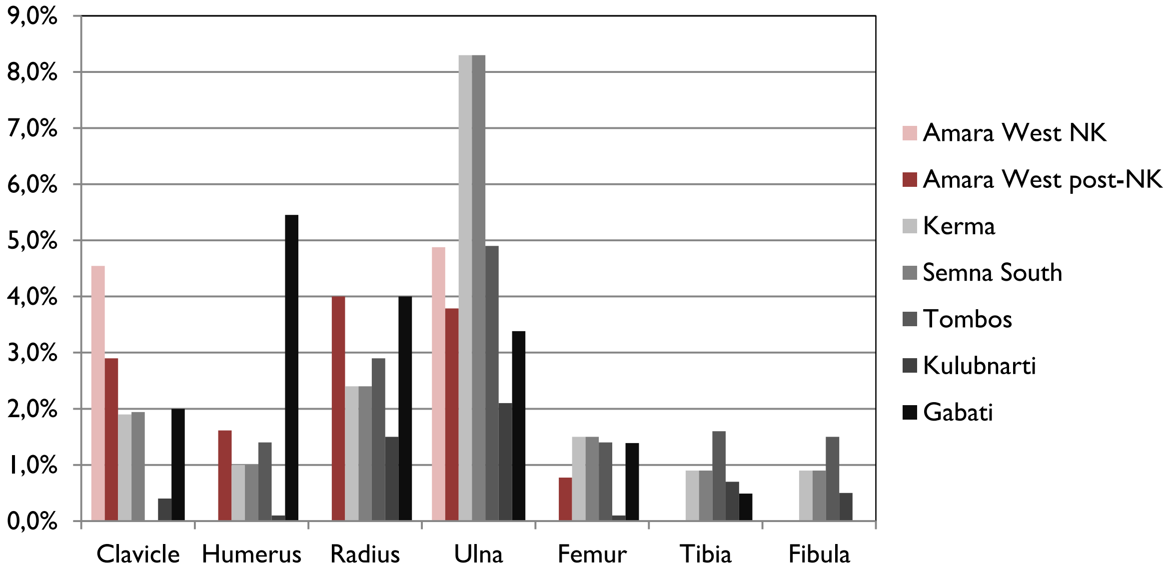

Figure 9.25 Comparison of fracture prevalence for different long bones at Amara West and other sites in Sudan (% of bones affected to bones observed)

Bone	Amara West NK	Amara West post-NK	Kerma[1]	Tombos[2]	Semna[3]	Kulubnarti[4]	Gabati[5]
Clavicle	4.5	2.9	1.9	n/a	1.9	0.4	2.0
Humerus	-	1.6	1.0	1.4	1.0	0.1	5.5
Radius	-	4.0	2.4	2.9	2.4	1.5	4.0
Ulna	4.9	3.8	8.3	4.9	8.3	2.1	3.4
Femur	-	0.8	1.5	1.4	1.5	0.1	1.4
Tibia	-	-	0.9	1.6	0.9	0.7	0.5
Fibula	-	-	0.9	1.5	0.9	0.5	-

Table 9.18 Comparison of long bone fracture patterns between individuals from Amara West and other Sudanese archaeological sites (data in %, frequency of bones affected compared to number of bones preserved, sources: [1] Judd, 2004, [2] Buzon & Richman, 2007, [3] Alvrus, 1999, [4]Kilgore, 1997, [5] Judd, 2012)

9.8.4. Fractures to the scapula, sternum and ribs

Fractures of the scapula were observed in one New Kingdom (9.1%) and two post-New Kingdom individuals (4.0%). They are uncommon today. accounting for only 1% of all fractures reported in western countries, and they therefore receive very little attention in the clinical literature (Goss, 1995). Reports in palaeopathology are equally rare, even though this may at least partially result from poor preservation of the scapula, and in particular the scapular blade (Roberts & Manchester, 2005: 104). Scapula fractures are the result of direct. high-energy trauma and in more than two thirds of modern cases they occur due to traffic related accidents (Theivendran *et al.*, 2008). Two of the examples found in the population from Amara West affected the acromion, which is the result of direct trauma to the tip of the shoulder (Resnick & Goergen, 1995: 2719). Fractures to the scapular blade, such those observed in two more post-New Kingdom individuals (see Figure III.119, III.121), occur after direct trauma to the back (Theivendran *et al.*, 2008). Scapular fractures are associated with a high level of morbidity. Between 80–95% of scapular fractures have also been reported to be associated with multiple often life-threatening injuries to the pulmonary organs, humerus, ribs or clavicles (Theivendran *et al.*, 2008).

One female individual suffered a comminuted fracture to the manubrium of the sternum see Figure III.120). Fractures to the sternum are generally rare and are usually caused by direct localised trauma to the upper chest (Recinos *et al.*, 2009). Due to their close proximity to the major vital organs such as the heart, lung, trachea and major blood vessels such as the aorta, injuries to the sternum are very commonly associated with additional damage to soft tissue (Resnick & Goergen, 1995: 2808) and are therefore potentially serious. with mortality rates ranging between 25–45% (Felten, 2012).

Rib fractures were overall the most common fractures in both time periods, affecting 16.0% of the New Kingdom and 20.8% of the post-New Kingdom group. Again, the range of mechanisms leading to rib fractures is wide. The most common aetiologies in modern clinical studies are direct blows to the chest and falls (Resnick & Goergen, 1995: 2812). Unless associated with damage to the internal organs, rib fractures are usually considered “benign” fractures. However. clinical studies have shown that a high percentage of patients with rib fractures also had secondary associated soft tissue injuries (Ziegler & Agarwal, 1994). Even though they are very commonly occurring fractures today, accounting for 10–15% of all reported fractures (Ziegler & Agarwal, 1994), the epidemiology of rib fractures in the past is not very well known as they are not very often part of the spectrum of fractures analysed in palaeopathological trauma studies (Brickley, 2006). Reported frequencies range from 15.6% to 23.6% of individuals in European archaeological samples, but data from comparative sites in Sudan and Egypt were not available. With 16.0% (New Kingdom) and 19.8% (post-New Kingdom) of individuals affected, the frequencies observed at Amara West can therefore be regarded as relatively high.

9.8.5. Fractures of the hands and feet

The hand represents the most commonly fractured part of the body in modern populations around the world (Schraga, 2013). In the people living at Amara West, fractures to the hand bones were also common, occurring in the metacarpals in six post-New Kingdom individuals, and phalanges in one New Kingdom and four post-New Kingdom individuals (overall 8.3% of the New Kingdom and 14.5% of the post-New Kingdom population). Injury mechanisms include a wide range of possibilities, including direct impacts, combat, and falls on the outstretched hand (Schädel-Höpfner & Windolf, 2010: 338, 346). The same processes (falls but also the impact of heavy objects) are responsible for fractures of the metatarsals and phalanges (Resnick & Goergen, 1995), and were also experienced by one New Kingdom (10.0%) and seven post-New Kingdom individuals (13.2%).

The observed prevalence of hand and foot bone fractures in the Amara West population is relatively low in comparison to modern clinical studies. Palaeopathological data for comparison are rare. Hand and foot bones are often less well preserved in the burial context than larger skeletal elements. As a consequence. these areas are not very often included in palaeotrauma studies and, if they are, they are not necessarily published. Roberts & Manchester (2005: 103) report relatively low frequencies in past human populations which they believe to be due to poor survival in/recovery from archaeological sites. Waldron in contrast (2009: 149) found hand and foot fractures to be amongst the most commonly occurring fractures in an archaeological population he analysed.

9.8.6. Fractures of the spine

9.8.6.i. General remarks

Fractures in the spine can affect the neural arches, transverse and spinal processes or the vertebral bodies. Due to differences in the complex anatomy of the spine, the mechanisms underlying fractures differ considerably within each vertebra as well as in different sections of the spine. This was already observed by ancient Egyptian physicians, as is evidenced in the Papyrus Edwin Smith (Van Middendorp *et al.*, 2010). In modern medical research, a number of classification schemes with varying levels of detail have been developed based on fracture mechanism, anatomical location and stability of the injury (e.g. Denis, 1983, Magerl *et al.*, 1994), even though there appears to be considerable disagreement as to which one is the best to use (David *et al.*, 2010b). Due to differences in biomechanical properties, the cervical spine is usually treated seperately, whereas fractures to the thoracic and lumbar spine are usually discussed together as these areas of the spine share similar anatomical and functional properties (David *et al.*, 2010b). The currently most widely applied classification of thoracolumbar fractures was developed by Magerl and co-workers (1994) and divides vertebral fractures into compression, traction and torsion according to patho-mechanical characteristics. In a recently revised version of the original scheme proposed by Magerl, fractures of the thoracic and lumbar vertebrae are classified into vertebral body fractures (Type A), injuries to the anterior and posterior elements with distraction (Type B) and anterior and posterior element injuries with rotation (Type C), based on the mechanism, anatomical location and stability of the injury (Reinhold *et al.*, 2013). Each of these types is further divided into several subcategories. Understanding the morphology and pattern of injury to the vertebrae is crucial as it provides important information about the underlying mechanisms. However, while these classification schemes have major implications for inferring severity, secondary symptoms and treatment in a clinical context, they are only of limited value to palaeopathological research. This is because much information about fracture morphology is lost because healed vertebrae are usually what is observed in palaeopathological analysis. Therefore, palaeopathological classification is usually confined to purely biomechanical considerations, dividing vertebral fractures into compression fracture, wedge fracture or oblique fractures of the posterior structures (Lovell, 1997). However, due to the high prevalence in the population from Amara West, fractures to the spine deserve more detailed consideration as to the anatomical location of the fracture within the vertebra, as well as the level of the spine affected, which can both hold important information about the underlying injury mechanism.

9.8.6.ii. Fractures of the cervical spine

According to modern epidemiological data, cervical spine injuries only account for 15–20% of all spinal fractures today. The main mechanisms involved in fractures of the cervical vertebrae are hyperextension, hyperflexion or axial loading even though, due to functional and morphological differences, responsiveness and fracture patterns vary between the upper and lower cervical vertebrae. In clinical practice, cervical spine injuries are accident-related in the vast majority of cases, resulting from falls, car- or cycle-crashes (Linhardt *et al.*, 2011: 450). Only three examples of fractures to the cervical spine were recorded in the population from Amara West, affecting only post-New Kingdom individuals. One individual suffered from a double compression fracture of the lower vertebral bodies (C5 and C6). Cervical vertebrae C3–C7 are generally, by far, more commonly affected by fractures in clinical studies (Patria, 1995: 2856). Compression fractures in these structures require considerable forces and result from axial loading with or without flexion (Davenport, 2013). If the posterior structures are unaffected, as is the case for the individuals from Amara West, they are considered stable (David *et al.*, 2010b: 239).

The male, middle-adult individual 314-16 had a healed fracture of the posterior arch of the atlas (see see Figure III.123). Isolated fractures in this anatomical location are always caused by hyperextension in combination with axial loading such as a fall on the head (David *et al.*, 2010b: 237-238). The two halves of the posterior arch are separated, suggesting a congenital mid-line cleft which may have facilitated injury to the atlas arch. The fracture is well healed even though the medial fragment appears slightly displaced antero-lateral into the spinal foramen. Serious complications of atlas fractures are unusual (Levine & Edwards, 1991), even though the subsequent displacement seen in Sk314-16 would have likely impinged on the spinal cord and could have potentially led to neurological symptoms.

9.8.6.iii. Fractures of the thoracic and lumbar spine

In the inhabitants of ancient Amara West, the thoracic and lumbar vertebrae were by far more commonly affected by fractures than the cervical vertebrae. This also corresponds with modern clinical data derived from studies in Europe and the US (Patria, 1995: 2875). Fractures to the posterior structures (neural arches) were generally less affected in both groups than the vertebral bodies. The pattern of level involvement is also different between the two areas of the spine. The clinical relevance of fractures to the neural arches varies greatly according to what portion is affected (Denis, 1983). Table 9.19 shows neural arch fractures in relationship to their anatomical location. The most common location for neural arch fractures observed in the sample was the spinous process (54.5% of all cervical fractures, see Figure III:124), followed by articular process (27.3%) and transverse processes (18.2%, see Figure III.122). Fractures of these structures in isolation are usually considered minor, stable fractures (Denis, 1983) unless they are associated with fractures to vertebral bodies or rupture of the vertebral discs (David *et al.*, 2010b: 261-264). All neural arch fractures observed at Amara West were well healed and occurred in isolation, and therefore do not suggest significant complications arising post- injury. Fractures of the transverse process in the lumbar spine result from rotational injuries (Magerl *et al.*, 1994). They commonly occur in falls on the back due to avulsion of the process caused by intense spasm of the psoas muscles when the spine strikes the ground (Gertzbein *et al.*, 2012). While avulsion fractures of the spinous processes of C7–Th1 ("Clay-Shoveller's-Fracture") are relatively common and well researched in the clinical context (Patria, 1995: 2861), reports of isolated fractures of the spinous process of all other thoracic and lumbar vertebrae are extremely rare (Kose, 2006). This is potentially due to the fact that, if isolated, they are of minor clinical significance, are not easily detected on conventional radiographs, and therefore are often overlooked (Matz & Reeder, 1999). Fractures of this type can either occur due to avulsion of the part of the vertebra in hypertension or hyperflexion, or be due to direct trauma, and have been reported in patients who have been hit by a car or who have fallen from a great height (Kose, 2006).

		Thoracic spine	Lumbar spine	Total
Spinous process	**n**	6	0	**6**
	%	85.7	0.0	**54.5**
Transverse process	**n**	0	2	**2**
	%	0.0	50.0	**18.2**
Articular process	**n**	1	2	**3**
	%	14.3	50.0	**27.3**
Total	**N**	**7**	**4**	**11**

Table 9.19 Location of neural arch fractures (n=number of fractures in part of vertebrae, N=total number of neural arch fractures section of the spine; time periods pooled)

However, regardless of injury mechanism or associated lesions, fractures to these structures always require considerable force and are therefore often associated with injuries to the underlying soft tissue and organs (Ghobrial, 2013). Clinical studies have shown that fracture to the transverse process of lumbar vertebrae, observed in two of the Amara West individuals, causes abdominal trauma in half of the observed patients. This proved to be significantly higher than in patients with other types of lumbar fractures not involving the transverse processes (Miller *et al.*, 2000). Fractures to the transverse processes of the lumbar vertebrae either result from rotation or extreme lateral bending injuries and are usually caused by direct blunt trauma related to car crashes (Krueger *et al.*, 1996)

By far the most common location of spinal fractures at Amara West was on the vertebral body. While in the palaeopathological literature, classification of vertebral bodies is based on morphological appearance, varying between compression and burst fractures (Lovell, 1997) or compression and wedge fractures (Waldron, 2009: 139), clinical classifications are again more complex. Following Magerl's classification (1994), deformation of the vertebral body can result from impaction (compression of the cancellous bone, hourglass, wedge or collapsed vertebrae), split or burst fractures. Assigning fractures to any of the categories partially depends on associated damage to the ligamentous and cartilaginous structures, as well as on mechanisms that will remain unknown to the palaeopathologist. Most importantly, some characteristics are shared by all types of vertebral body fractures: they are caused by axial loading with or without flexion and, with the exception of severe compound split or burst fractures, are usually stable and do not cause any significant neurological damage (Magerl *et al.*, 1994). In modern epidemiological studies of spinal trauma, road traffic accidents are by far the single most common cause of spinal injuries, followed by falls from heights, and to a much lesser degree violent trauma (Cripps *et al.*, 2011, Draulans *et al.*, 2011). Unfortunately, even though systematic surveys have been carried out in a large number of countries and regions, no comparative data is available for Sudan or Egypt. In less mechanised or motorised societies, spinal trauma caused by falls from great heights (particularly trees and roofs) are of much higher prevalence, and in some cases even exceed traffic accident-related trauma (e.g. Karamehmetoglu *et al.*, 1997, Karacan *et al.*, 2000, Draulans *et al.*, 2011).

The most common reason, or rather precipitating factor, for compression fractures of the vertebral bodies in modern clinical practice is underlying osteoporosis (David *et al.*, 2010b). Osteoporosis and its precursor, osteopenia, is generally defined as reduced bone density and is a chronic, progressive disease of multifactorial aetiology (Jacobs-Kosmin, 2013). While age has been long thought as the main risk factor, other major influences are dietary components and dietary deficiencies, genetic background and hormonal status. The two main forms of osteoporosis are senile osteoporosis, usually occurring in men and women over 70, as well as menopausal and post-menopausal osteoporosis affecting women in or past these stages (Jacobs-Kosmin, 2013). Due to reduced bone density and increased structural weakness of the cancellous bone, the vertebra is more prone to fracture. In individuals with normal bone mineral density, high-force trauma, which is either due to severe direct trauma (e.g. road traffic accidents, being struck by a vehicle or other fast-moving object. assaults), or falls from heights above standing height, is required to produce vertebral body fractures (Mackey *et al.*, 2007).

With increasing loss of bone density, the amount of force required to produce a fracture decreases and people with severe osteoporosis who even cough might fracture their vertebrae doing so. The most commonly occurring type of fracture in osteoporotic spines is the complete collapse of the vertebral body and significant loss of height, even though other forms, such as hourglass or wedge fractures. can also occur (Magerl *et al.*, 1994). Differentiating between fractures due purely to accidental trauma or due to underlying osteoporosis has implications for determining the injury mechanism and force and is difficult to apply to archaeological populations, particularly in skeletons where early stages of osteoporosis may be present but not discernible without the aid of further diagnostic techniques such as radiography. In skeletal human remains, osteoporosis can be diagnosed through radiographic or histological analysis (Brickley & Ives, 2008: 176), but when individuals have very advanced osteoporosis they may be diagnosed through visual examination alone (Brickley & Agarwal, 2003). In addition, the presence of osteoporotic related fractures of the femoral neck and of the distal radius, as well as compression fractures of the vertebral bodies, which are commonly observed in osteoporotic people in modern populations, has been used to infer osteoporosis in past human populations (e.g. Brickley, 2002).

An underlying contribution of osteoporosis to the high prevalence of vertebral body fractures in the individuals at Amara West has to be taken into account. Skeletal changes which can potentially be attributed to osteoporosis were observed in one New Kingdom and one post-New Kingdom female. In Sk234-3, the trabecular bone of the vertebral bodies shows extensive atrophy, highly enlarged inter-trabecular spaces and free-standing trabeculae (see see Figure III.111). In addition, the cortex of the long bones appeared "paper thin" in cross-section. No age at death-markers were preserved for this skeleton, but the complete ante-mortem loss of all maxillary and most mandibular teeth, as well as advanced joint disease, tentatively suggests this person was at least of middle age at death. Similar thinning of the cortex of the long bones was observed in a middle adult female individual from a post-New Kingdom niche tomb. The remains were disturbed, and the skeleton is not complete, and therefore it is not possible to observe the full spectrum of changes. Vertebrae could not be assigned to this individual. However, even though the thinned cortices observed in the long bones and thinning of the trabecular structures in the joints cannot be taken as conclusive evidence for the presence of osteoporosis, they are at least highly suggestive.

These findings indicate that osteoporosis represented a health problem at Amara West too. In the absence of further investigative techniques systematically applied to infer bone density, potential inferences about the role of osteoporosis in the health of individuals from Amara West is also provided by assessing the demographic profile (see Table 9.20). Today senile osteoporosis usually affects men and women over 70 years. while post-menopausal osteoporosis usually occurs in women over 50 years (Jacobs-Kosmin, 2013). Due to genetic and hormonal factors, women are by far more commonly affected by reduced bone density and osteoporosis than men (Woolf & Pfleger, 2003). In the population from Amara West, the majority of vertebral body fractures also occurred in female individuals. With one exception, the individuals affected were below 50 years of age. However, most of them were in the middle adult range and therefore within an age range where the menopause could have already affected them. Even though the mean age of menopause today ranges around 50 years of age, studies have shown that a number of life-style related factors such as poor nutrition, lower socio-economic status, heavy work load and smoking can lead to an early onset (Gold, 2011). Bioarchaeological data show that significant environmental pressures affected the women at Amara West which may have also had an effect on the age of onset of the menopause. Consequently, a certain degree of decreased bone density cannot be excluded. Nevertheless, none of these individuals showed any obvious signs of severe osteoporosis, and thus high-impact trauma due to falls or blows would have still been necessary to cause the observed vertebral body fractures in the young and middle adult individuals. In addition, due to biomechanical properties, osteoporosis-related compression fractures most commonly affect the middle and lower thoracic and upper lumbar spine, whereas the upper thoracic and lower lumbar vertebrae are only rarely involved (Patria, 1995: 2869, 2876).

	New Kingdom			**Post-New Kingdom**		
	Female	**Male**	**Indiff.**	**Female**	**Male**	**Indiff.**
Young adult	-	-	-	2	-	-
Middle adult	1	1	-	4	1	2
Old adult	-	1	-	1	-	-
Adult indet	-	-	-	1	-	-
Total	**1**	**2**	**-**	**8**	**1**	**2**

Table 9.20 Demographic profile of individuals with vertebral body fractures

Comparing the data from Amara West to other sites again proved difficult as spinal trauma is generally rarely discussed in the palaeopathological literature and, if so, standards of data presentation vary considerably. In the South Tombs Cemetery at Amarna, 20 out of the 95 adult individuals displayed compression fractures of the vertebral bodies, even though the value is of limited use because it remains unclear whether this represents the number of individuals in the entire collection or number of individuals with observable spines (Kemp *et al.*, 2012). While neither at New Kingdom Tombos (Buzon & Richman, 2007) nor medieval Kulubnarti is spinal trauma reported at all, in Judd's (2004) study of trauma in Kerma period individuals (1750–1500BC), spinal trauma is included with scapula and rib fractures and shoulder dislocations.

9.8.6.iv. Fractures of the pelvis

The pelvis fractures observed in two post-New Kingdom individuals from Amara West (4.7%) affected the iliac blade, as well as the superior and inferior pubic ramus (see see Figure III.132, III.133). Similar to modern European epidemiological data (Naumburger *et al.*, 2010: 295), in archaeological human remains fractures of the pelvis are very rare (Roberts & Manchester, 2005: 104, Hofmann *et al.*, 2010). In the 6000 skeletons examined during the First Archaeological Survey of Nubia Wood Jones reported a frequency of 3.75% (Jones, 1908). In modern clinical practice, fractures to these structures are summarized under the term "pelvic ring fractures". Classifications of pelvic ring trauma are based on pelvic stability, which is dependent on the degree to which the posterior ligamentuous and bony structures are disrupted (Naumburger *et al.*, 2010: 298). In the two individuals from Amara West the sacro-iliac joint and pubic symphysis of the individuals affected do not suggest any major damage to the joint structures, and the fractures to the iliac blades only affect their superior portions. Therefore, they fall under Type-A fractures, which are considered stable (Naumburger *et al.*, 2010: 298–300). Isolated fractures of the iliac blade are also referred to as "benign fractures", even though recent studies have shown that, due to the close proximity of internal organs and major blood vessels, potentially life threatening soft tissue injuries occur in a large number of cases (Abrassart *et al.*, 2009). With regard to mechanism, regardless of the type of fracture occurring, pelvic fractures always presuppose direct high-force trauma and are nowadays most commonly seen in road traffic accidents (>50% of the cases) and falls from great heights (Resnick & Goergen, 1995). Unilateral iliac wing fractures, such as those observed in the two individuals from Amara West, are usually caused by high-velocity lateral impact (Abrassart *et al.*, 2009).

9.8.7. The fracture pattern at Amara West in context

The fracture pattern seen in the people from Amara West indicates that life in the settlement featured many risk factors, putting people at risk of accidental injuries, particularly involving falls from heights. The terrain surrounding Amara West does not include any significant cliffs or rock-faces and therefore does not necessarily lend itself to representing a major risk in itself. However, through the archaeological evidence from the town, combined with ethno-archaeological and clinical data, a number of potential risk sources can be identified in the living environment of the inhabitants of Amara West.

One major risk source can be found in the houses of Amara West. Discoveries of roofing fragments from several houses indicate that roofs and ceilings where constructed from wooden beams and reed bundles covered with mud. The presence of upper storeys is not yet proven at Amara West but staircases are found in the majority of the houses excavated at Amara West (see Figure 9.26), as well as in comparative examples from contemporary settlements such as Tell el-Amarna (Kemp & Stevens, 2010a) certainly make this a very likely possibility. Either way, the staircases indicate that upper levels of some sort were meant to be used by the inhabitants. Habitual use of the roofs of houses for different activities such as sleeping during hot periods, storage, or as a work area, is a practice that is still commonly found in some parts of Northern Africa and the Middle East, even though it is relatively uncommon in modern Nubia. Although very little is known about the impact of this behaviour on injury epidemiology, it was identified as a major reason for a high prevalence of spinal cord trauma in a large-scale survey of living populations in South-East Turkey (Karamehmetoglu *et al.*, 1997). It was also suggested as a reason for the high frequency of fractures in the population of Kulubnarti (Kilgore *et al.*, 1997). It could therefore also account for some of the fractures occurring at Amara West.

Figure 9.26 Staircase leading to an upper room or roof at Amara West

Another major source of risk for fall-related accidents may also be sought in "interactions" involving trees. For example, a high prevalence of spinal fractures has been reported in populations where the spectrum of agricultural activities includes harvesting plants from high trees (Ebong, 1978). In rural Papua-New Guinea, in an area void of any road traffic, falls from trees have been found to account for 41% of all fractures in the population (Barss *et al.*, 1984). The most common fractures sites were the clavicle, humerus, radius, and ulna, while the ribs, spine and lower extremity bones were less frequently affected. The archaeobotanical record provides ample evidence that doum palm nuts were consumed by the people living at Amara West (Ryan *et al.*, 2012). Harvesting and tending of palm tree fruits has been carried out by people climbing trees since Pharaonic times (Price, 2013), a practice that can still be observed in parts of Egypt and Sudan today. Doum palms can reach heights between 9–20m[8], and climbing them would have certainly put people at risk of fall-related accidents.

A number of fractures observed in the population such as those to the medial clavicle (two examples), scapula (three examples), and sternum (one example) may have been caused by direct, high-velocity impact, such as those seen in modern road traffic accidents, and these may be related to causes other than falls. In studies of modern American farming communities, the most common source of traumatic injuries are interactions with large animals (e.g. Cogbill & Busch, 1985, Gerberich *et al.*, 2001, Prince, 2006: 32). In non-mechanised countries, this is even more prevalent (Letz & Lessenger, 2006). Besides horses, the animals most often causing injuries in farm workers are cattle (Murphy *et al.*, 2010), followed by dogs and smaller animals (Norwood *et al.*, 2000). A similar explanation would certainly be consistent with the fracture pattern seen at Amara West, particularly with regard to more unusual high-force trauma such as fractures to posterior parts of vertebrae, and the bones of the shoulder or pelvis. Amongst the most common cattle-related injuries are also scalp lacerations, with or with underlying bone damage, as well as other forms of skull trauma (Murphy *et al.*, 2010). This may therefore also account for the high number of minor skull injuries observed in this group.

In diachronic comparison, the data suggest a considerable increase in the total number of fractures in the later post-New Kingdom. Even though there are differences, with regard to the general pattern of elements affected by trauma, no evidence indicates a systematic shift in risks or injury mechanisms. During both time periods blunt-trauma related to falls or direct impact prevails as the main underlying cause. Whether the increasing prevalence of trauma in the post-New Kingdom period is indeed real or rather represents an artefact of differences in sample size, remains unknown. However, even though this remains highly speculative, several explanations

[8] http://www.efloras.org/florataxon.aspx?flora_id=5&taxon_id=250077151 [accessed 13. 11. 2013]

that may account for the observed differences appear within reason, particularly in the light of changing environmental conditions. One of the common responses to progressing aridification, particularly in Eastern and Southern Africa, is the shift from agriculture to increasing dependence on animal husbandry because herds of animals are easier to sustain than agricultural land (Geist, 2005: 71). The causal relationship between fracture risk and handling of large animals has already been outlined above. Thus, if the people living at Amara West applied strategies to cope with the proposed environmental deterioration similar to the people living in the fringe regions of the Sahara desert today, one might also expect to see an increase in animal-related injuries. As an alternative explanation it remains possible that the increase in vertebral body fractures during the post-New Kingdom periods reflects higher levels of osteopenia and osteoporosis caused by increasing nutritional deficits in the wake of environmental deterioration.

One of the most striking features of the fracture profile at Amara West is the almost complete absence of fractures of the long bones of the lower extremities. Due to their common occurrence in modern and bioarchaeological studies, the absence in the Amara West sample appears surprising. The presence of other injuries shows that mechanisms/risk factors responsible for long bone fractures, including those of the lower limb, such as falls from heights, would have certainly been in place in the ancient settlement of Amara West. However, falls from heights do not necessarily result in fractures of the lower limb bones. They were only observed in about 10% of patients in a large scale study of people who fell from flat roofs, while the vast majority suffered from fractures to the skull and thoracolumbar spine (Yagmur *et al.*, 2004). Similar data are seen in an Australian population study, with the lower limb being the least commonly affected part of the body in falls from trees, roofs and ladders (Kent & Pearce, 2006). Therefore, the absence of limb fractures does not contradict the claim that people at Amara West were exposed to a high risk of accidental falls. However, the human skeletal remains analysed in this study only represent a subsample of the original living population in the area (Wood *et al.*, 1992), and consequently the results obtained in this study cannot be seen as representative of the entire population.

Specific types and patterns of fractures have also been used in bioarchaeological studies to infer levels of interpersonal violence. The most commonly cited marker for violence and warfare is a high prevalence of cranial injuries (e.g. Walker, 1989, Jurmain & Bellifemine, 1997). Similar inferences are usually drawn for fractures of the nasal bones (e.g. Walker, 1997). In Nubian populations, high prevalence rates of skull trauma and "Parry" fractures have been interpreted as direct evidence of warfare between the Kingdom of Kerma and the Pharaonic Empire during times of Egyptian colonisation attempts (Filer, 1992, Filer, 1997, Judd, 2004). A large number of small depression fractures were observed in the skulls from Kerma and were interpreted as manifestations of violent insults caused by clubs, sticks or stones (Filer, 1992). Whether similar reasons could account for the observed examples at Amara West remains unclear, particularly since the ambiguous nature of the lesions does not allow for any secure inferences about injury mechanisms. Some of the fractures observed at Amara West, such as isolated fractures to the ulna or fractures of the skull, may well have been caused by violence-related injury mechanisms.

Clear violence related injuries were not observed in any of the groups, and archaeological evidence of weaponry is almost entirely absent from Amara West. Even though there are some textual and iconographic sources attesting to repeated Egyptian campaigns against the Nubians during the New Kingdom period, their extent and location remains unclear. The arrangment of the settlement at Amara West with its extramural suburbs generally suggests that defense was no major concern and therefore indicates an environment free of armed conflict likely to have been commonplace in houses at Amara West: impressions of jar-stands in mud floors are often found beside low mastaba-benches. The history of the post-New Kingdom period is even less well known. The demographic distribution of fractures to the skull shows a slight predominance of men (eight individuals) over women (five individuals), even though the difference and sample size is too small to be regarded as significant. However, none of the observed injuries can without doubt be attributed to any form of weapon or violent trauma, and they may as well be explained by falls or encounters with large animals. Skull vault and nasal injuries can result from a wide variety of causes besides inter-personal violence, including being struck on the head by any fast moving object (Oehmichen *et al.*, 2006: 116–117, Haraldson, 2013). A certain degree of interpersonal violence to account for these injuries can certainly not be excluded – as is potentially the case in the vast majority, if not all, populations present or past. Nevertheless, the prevalence of "classic" fractures usually associated with interpersonal violence such as skull fractures or isolated ulna fractures is so small that even if they were caused by inter-personal violence they do not represent any significant levels thereof. Therefore, based on the skeletal evidence alone, it is not possible to infer violent behaviour or warfare affecting the people at Amara West during the New Kingdom or post-New Kingdom periods.

9.8.8. Fracture treatment and care within the community

The analysis of evidence of fractures in the population showed that broken bones represented a relatively common aspect of daily life at ancient Amara West. The vast majority of the observed fractures were not only healed but also showed a remarkable degree of good alignment. While in the ribs, metacarpals, metatarsals, radius or ulna (if broken alone), this is not surprising as their anatomical position usually ensures natural/anatomical splinting and alignment. In fractures of the pelvis, humerus or femur the attached muscles often lead to significant displacement and shortening of the bone if left untreated (Jones, 1908: 129, Roberts & Manchester, 2005). Therefore, examples like the relatively well healed pelvis or femoral shaft fractures may indicate some basic form of treatment. Textual evidence reveals a very complex anatomical knowledge and understanding of fractures by ancient Egyptian medical practitioners (Nunn, 1996: 56). The most comprehensive source of information about trauma is the Papyrus Edwin Smith dating to c. 1500BC, perhaps originating in earlier documents dating to c. 3000BC (Breasted, 1930, Sanchez & Meltzer, 2012). The text contains 48 cases of fractures and injuries of the upper body, based on typical appearance rather than individual cases, which are arranged in anatomical order starting from the head (Van Middendorp *et al.*, 2010). Unfortunately, the papyrus ends before describing the lower body regions. The data on long bone fracture treatment is further supported by repeated archaeological findings of splints associated with broken limbs in tomb contexts dated from the 3rd millennium BC onwards. How far this expertise would have spread to the far reaches of the Egyptian Empire remains unknown, and no knowledge exists about indigenous medical practices in Nubia at that time. However, both Smith and Jones (1908) observed a high degree of well aligned healed fractures in the human skeletal remains analysed during the Archaeological Survey of Nubia

In addition, based on clinical and anatomical observations, it seems likely that some of the fractures observed at Amara West would have required significant force, and therefore would have likely been associated with major injuries to underlying organs. This is particularly the case for fractures of the pelvis and lumbar spine, but also for fractures to the medial clavicle which, in modern clinical studies, have been found to be associated with mortality in up to 20% of people affected (Throckmorton

& Kuhn, 2007). In order to secure survival and the degree of healing that is seen in most of these fractures, a certain degree of treatment and care would have certainly been necessary.

That this was not always successful can be seen in the female individual Sk237. The fractures to the sternum and several ribs only showed initial healing but the newly formed bone surrounding the fracture is still active, which indicates that the individual died before the fracture was fully healed. Isolated fractures of the sternum are not necessarily problematic but, if they occur associated with other injuries to the thorax or spine, mortality rates range between 25 and 45% (Khoriati *et al.*, 2013). The presence of un-united rib fractures indicates multiple trauma, and thus potential injuries to the chest organs, which can ultimately lead to death, appear a likely possibility. However, the presence of some new bone formation and partial union indicates survival for some time. Depending on the type of bone fracture, state of health of the individual, and other external factors, primary callus formation (woven bone) typically takes six weeks (Ortner, 2003: 126). Deposition of woven bone usually starts after the 3rd week of fracture healing. Therefore, the woman from Amara West would have survived at least 3–4 weeks after the injury occurred, which may suggests that some form of care was provided within the community, even though of course any such claims remain impossible to proove. Other fractures, such as those of the pelvis and the femur, would have at least temporarily led to disability, which equally presupposes care. In iliac wing fractures, treatment is usually non-surgical but prolonged periods of stabilisation of rest are required to ensure healing (Russell, 2012).

9.9. Neoplasms

9.9.1. Metastatic carcinoma

Neoplams were not systematically assessed in the population from Amara West. Only one individual with evidence for a malignant cancer (Sk244-8) was found in the New Kingdom population of Amara West (Binder *et. al.* 2014). For the observed skeletal changes, four differential diagnostic options have to be taken into account: metastatic carcinoma, multiple myeloma, fungal disease and taphonomic damage. These will be briefly discussed in the following.

The most common source of metastasizing tumors affecting the skeleton are metastatic organ tumors (Dorfman & Czerniak, 1998: 1009). Bone involvement develops through the spread of tumor cells spread to the bones either through direct extension of a primary soft tissue tumor, through the lymphatic system, cerebro-spinal fluid or most importantly through hematogenous dissemation. Consequently, bone structures rich in haematopoetic bone marrow (vertebrae, pelvis, ribs, sternum, skull, clavicles, scapulae, humeral and femoral heads) are the most commonly affected elements (Resnick, 1995: 4257). The peripheral elements of the skeleton distal to the elbow and knee are only very rarely involved (Greenspan & Remagen, 1998: 366). Depending on the source of the cancer, the changes caused by metastatic tumours can either be osteolytic (75%, thyroid, kidneys, adrenal glands), osteoblastic (15%, prostate gland) or mixed (10%, lung, breast, cervix, ovaries and testicles) (Greenspan & Remagen, 1998: 368). However, none of these patterns is without exception (Resnick, 1995: 4284). The type, distribution and density of metastatic lesions are dependent on the primary source of the tumour as well as on the duration of the disease. The osteolytic lesions result from bone resorption due to growth of tumour cells commencing in cancellous bone and are characterised by internal scalloping. The cortical bone is only involved in advanced stages of the disease process (Ortner, 2003: 535). Consequently, the number and size of lesions visible upon radiographic examination usually exceeds the number of lesions visible externally, making the radiographic appearance of lesions one of the key differential diagnostic features of metastatic carcinoma (Rothschild *et al.*, 1998). Depending on the aggressiveness of the disease process, the lesions can range between well circumscribed (geographic) to poorly defined (motheaten or permeative) bone destruction seen in more aggressive types (Resnick, 1995, Rothschild *et al.*, 1998). Single metastases are rare; in the majority of cases multiple lesions are present (Dorfman & Czerniak, 1998: 1013).

Multiple myeloma is a neoplastic condition affecting the plasma cells of bone marrow (Dorfman & Czerniak, 1998: 664). Similar to metastatic cancer, multiple myeloma causes a multitude of small, circular lesions in bone (Rothschild *et al.*, 1998). Differentiating between multiple myeloma and metastatic carcinoma in dry bone is considered a major challenge and may not always be possible (Ortner, 2003, Marks & Hamilton, 2007). In contrast to metastatic carcinoma, multiple myeloma produces small, uniformly sized, spherical lesions with effaced edges, which are much denser and more regularly distributed. In addition, remodelling along the edges of lesions or new bone formation, as is seen in the individual from Amara West is absent in multiple myeloma (Rothschild *et al.*, 1998) because osteoblast formation is suppressed in tumoric foci of multiple myeloma (Sezer, 2009, Yaccoby, 2010).

Lytic lesions similar in appearance to metastatic carcinoma can also occur in several fungal infections (Hershkovitz *et al.*, 1998). However, with the exception of African histoplasmosis, skeletal involvement is generally rare (Aufderheide & Rodríguez-Martín, 1998: 217). Bone infection caused by fungi results from secondary haematogenous dissemination. The resulting skeletal lesions are almost exclusively lytic in nature and new bone formation is only very rarely reported (Aufderheide & Rodríguez-Martín, 1998: 213). Differentiating between metastatic carcinoma and fungal infections is based on the appearance of the lytic lesions and the occurrence of bone remodelling. In mycoses lytic lesions characteristically occur as fronts of resorption, while the skeletal lesions in bone metastases are usually space-occupying (Hershkovitz *et al.*, 1998). Newly formed bone is rare in fungal infections but, if present, it usually appears as characteristic blunt spiculae (Hershkovitz *et al.*, 1998). Distribution of lesions is another differential diagnostic feature because in mycotic infections they occur throughout the skeleton including the distal portions of the long bones and small hands of the hand and feet. The lesions observed in the individual from Amara West do not conform to the features associated with fungal infection, thus leaving it an unlikely differential diagnosis.

Post-depositional damage to bone can mimic the osteolytic lesions caused by a tumour (Brothwell, 2012). A number of agents including the impact of roots, water, termites (Huchet *et al.*, 2011) or dermatid beetles (Huchet *et al.*, 2013) can produce small round holes and cavitations. While root or water damage is uncommon at Amara West, destruction likely caused by osteophageous insects represents a frequently occurring problem. However, insect damage differs considerable from pathological changes in the morphological characteristics of the holes as they do not expand within the bone but rather appear to be regular, punched out tunnels through the entire bone. A pathological origin of the observed pathological lesions is further supported by clear evidence of osteoclastic activity seen in the SEM images (see Figure 9.27) as well as periosteal new bone formation in the vicinity of some defects.

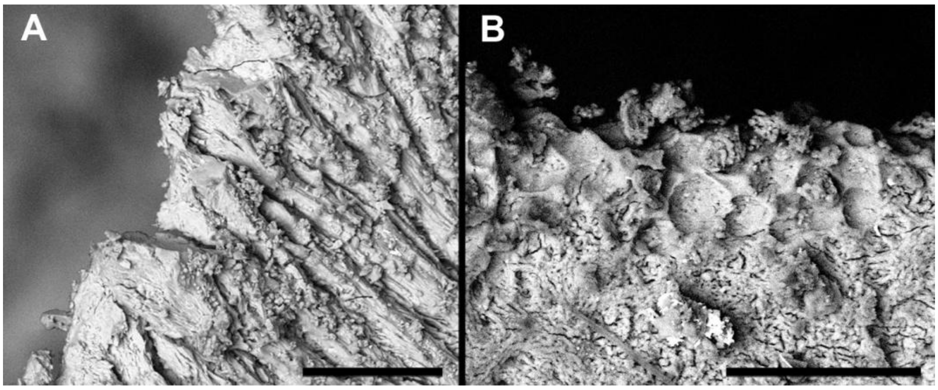

Figure 9.27 SEM images of post-mortem damage (A) and osteolytic lesion (B)

Consequently, size, shape and distribution of the irregularly shaped, often poorly defined to circular lesions observed in the ribs, vertebrae, clavicle, scapulae, pelvis, sternum, humeral and femoral heads of Sk244-8 leave a diagnosis of lesions arising from a metastatic carcinoma as the most likely cause for the observed pathological changes. A diagnosis of multiple myeloma can be excluded based on the irregular distribution and variable size and shape of the lesions. The source of the skeletal metastases remains unclear. Osteolytic or mixed lesions such as those seen in the individual from Amara West are most commonly seen in breast cancer, followed by the lung, thyroid gland and kidneys (Layer, 2005: 329). However, identifying the origin of the metastatic lesions based on the examination of dry bone alone is considered difficult, if not impossible (Ortner, 2003).

9.9.2. Cancer at Amara West

Even though the underlying source of the cancer in Sk244-8 remains unknown, the environmental and archaeological context provides some possible indications as to what could have led to the cancer observed in the man from Amara West. Even though today's leading causes of cancer are all products of modern living conditions and industrialisation, a large number of environmental carcinogens such as asbestos also occur naturally (Hueper, 1963), while other anthropogenic carcinogens have been present in the human living environment for a very long time. The carcinogenic effects of smoke from wood fires, particularly when indoors, are well known (Delgado *et al.*, 2005, Boyle & Levin, 2008). The use of fire indoors is well evidenced at Amara West (Spencer, 2014a). In modern Sudan, the common usage of fires in poorly ventilated rooms of small mudbrick huts is still considered one of the major factors leading to lung cancer (Awadelkarim *et al.*, 2012); similar conditions are common across early societies, including those where other evidence of cancer has been identified (Capasso, 2005). Bitumen, known also to cause cancer in individuals occupationally exposed to bitumen fumes (Binet *et al.*, 2002) was already used by ancient Egyptians for waterproofing or embalming (Serpico & White, 2000). Its presence at Amara West has not been proven, to date but the possibility of import of the material cannot be excluded.

Infectious diseases have also been identified as a cause of cancer (Polk & Peek, 2010). Schistosomiasis is now recognized as a common cause of bladder cancer (Sitas *et al.*, 2008). In addition, it has been associated with an increased risk of male breast cancer as a consequence of the hormonal disturbances resulting from liver cirrhosis secondary to schistosomiasis infection (Buzdar, 2003). This may also account for the fact that the male to female breast cancer ratio in modern Egypt is far greater than anywhere else in the world (Mustacchi, 2003). The possibility of schistosomiasis being present at Amara West has already been discussed in more detail in Section 9.2.3. Therefore, even though unproven to date, an underlying schistosomiasis infection leading to breast cancer in the man from Amara West remains a plausible explanation. The link between gastrointestinal cancer and infection by *helicobacter pylori*, which is recognized to have affected human populations since prehistory (Linz *et al.*, 2007), is also well established (Polk & Peek, 2010).

The individual from Amara West, only 25–35 years old at death, further underlines that cancer was restricted neither to old age nor elite social status. From a modern clinical point of view, the young age-at-death of the man from Amara West may seem unusual for the onset of skeletal metastases, but it remains unknown whether the underlying causes of cancer affected people in the same way and at the same speed as they do today.

9.10. Cardiovascular disease

9.10.1. Differential diagnosis of the calcified structures

Two New Kingdom and three post-New Kingdom individuals featured rounded, semi-circular calcified structures within the chest area and alongside the femur (Binder & Roberts, 2014). Several options can account for the observed calcifications. Calcifications or mineralisations are a common feature of cardiovascular disease, occurring in the artery walls, microvessels or valve leaflets (Demer & Tintut, 2008). By far the most common cause of arterial calcification is atherosclerosis (Demer & Tintut, 2008), generally defined as the thickening of the artery wall resulting from an accumulation of lipids in the arterial intima (Lusis, 2000). All major and medium-sized arteries can potentially be affected (Lam, 2012). The accumulated materials gradually form plaques or atheromata which, in advanced stages, can also incorporate calcium (Abedin *et al.*, 2004, Demer & Tintut, 2008). In modern clinical studies such calcifications are very common in individuals with atherosclerosis and are considered considered pathognomonic (Stary et al., 1995). Early stages of atherosclerosis prior to atheroma formation are considered clinically silent and can occur in children (Stary et al., 1994). Morbidity and mortality due to ischemia or thrombosis are only linked to the advanced stages and are usually seen from the third decade of life onwards where fibrous or calcified plaques are present (Stary et al., 1995).

Other forms of arterial calcification are generally relatively rare in modern populations (Abedin *et al.*, 2004, Demer & Tintut, 2008). Medial vascular calcification (Mönckeberg's arteriosclerosis) commonly occurs as a complication of diabetes mellitus and chronic kidney failure, but is also associated with advanced age (Towler, 2008). The pathways of calcification are different to atherosclerotic calcification, starting in the arterial media and usually affecting the entire arterial circumference. The most common sites for medial calcifications are the peripheral arteries of the lower limbs (Sinha et al., 2008). Calcification of microvessels can occur in metabolic conditions such as uremia and hyperparathyroidism, even though this is generally very rare (Demer & Tintut, 2008, Towler, 2008). None of these conditions is mutually exclusive and there can be considerable overlap, with atherosclerosis usually developing in due course (Demer & Tintut, 2008).

Dystrophic calcifications of soft tissue can also be caused by a large number of conditions and occur in different parts of the body, for example in the thoracic cavity, and intracranially, in joints, and in the pelvic and abdominal cavities (Steinbock, 1989, Baud & Kramar, 1991). Amongst the calcifications more commonly observed in palaeopathological studies are those of pleural tissue. These can develop secondary to inflammatory conditions of the lung (Baud & Kramar, 1991, Donoghue *et al.*, 1998) and have to be considered as a potential differential diagnosis for the calcified structures recovered from the chest area. However, pleural tissue calcifications are generally characterised by a relatively flat surface and an irregular shape (Light, 2012). Due to the non-specific nature of these calcifications and similar underlying pathophysiological mechanisms (Doherty *et al.*, 2003, Demer & Tintut, 2008), identifying the exact origin of a calcification in association with skeletal human remains is often very difficult, even histologically. In the palaeopathological record, calcifications are only occasionally reported, which may at least partially be explained by difficulties in diagnosis (e.g. Steinbock, 1989, Baud & Kramar, 1991, Komar & Buikstra, 2003, Perry *et al.*, 2008, Binder *et al.*, 2012).

The calcifications observed in the individuals from Amara West do not conform to the appearance known for any other condition. Morphological appearance, relative anatomical positions (see Figure 9.28) with the skeletons Sk244-4, Sk244-6, Sk237 and Sk243-3 and comparison with findings from intact mummies and clinical studies (e.g. Towler, 2008, Allam *et al.*, 2009, Thompson *et al.*, 2013) rather argues for an identification of calcified arterial plaques caused by atherosclerosis. The rounded, semi-circular calcifications recovered in the upper chest area of Sk244-6 (SS69a), Sk244-4 (SS68) and Sk243-3 (SS67) conform to an estimated diameter of c. 2–2.5mm , suggesting they originated in the *aorta descendens* or *aorta abdominalis suprarenalis* (Kahraman et al., 2006). The second larger calcification recovered with Sk244-6 (SS69b) is consistent with a diameter of 0.8–0.9cm which conforms to published dimensions of the subclavian artery in living people (Engelhorn et al., 2006). Calcifications in these vessels have also been reported in Egyptian mummies (Sandison, 1962). The calcifications in the lumbar area of Sk237 are consistent with the location of the iliac artery. Their curvature suggests an origin in a structure with a cylindrical shape of 0.5 – 0.7mm. This falls well within the standard range of the common iliac artery (Malnar et al., 2010) and further corresponds with CT-findings in

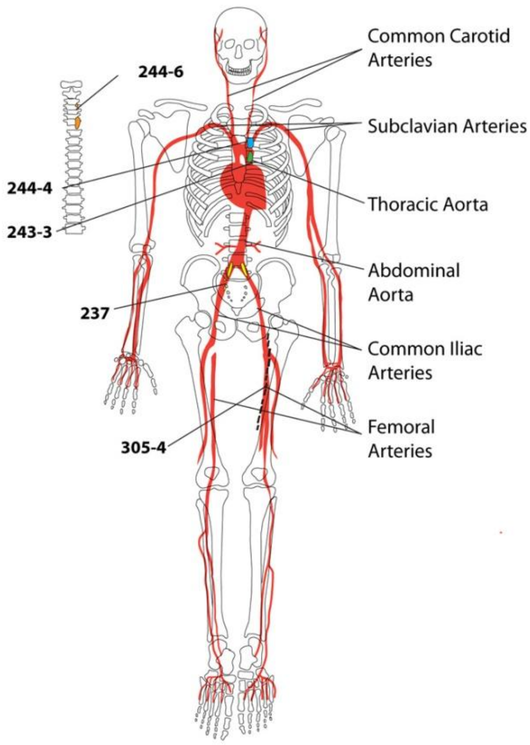

Figure 9.28 Anatomical location of calcified structures in relationship to the main arterial system

mummified human remains diagnosed with atheromatous plaques in the iliac artery (Allam *et al.*, 2009).

The calcifications associated with Sk305-4 differ from those observed in the other individuals as the entire circumference was calcified. Circumferential calcification is a common feature of medial arterial calcification (Lehto *et al.*, 1996, Towler, 2008). Medial calcification is particularly common in the uterine, femoral and tibial arteries (Sinha et al., 2008), thus appearing to be a likely cause for the calcifications observed in Sk305-4. The anatomical location of the calcified structures also corresponds with the common femoral artery and the observed diameter of 0.4–0.5 mms conforms to average values of intact femoral vessels in the living (Sandgren et al., 1999).

9.10.2. Cardiovascular diseases (CVCs) at Amara West in context

Atherosclerosis has a complex, multifactorial aetiology with genetic, environmental and life-style related risk factors (Lusis, 2000, Lusis *et al.*, 2004). A high-fat diet, smoking and lack of physical activity and hypertension are amongst the main life-style related factors which have mainly been blamed for the vast increase of CVDs in the 20th and 21st centuries (Rose, 1991). In recent years a number of infectious diseases such as *Chlamydia pneumonia*, *Helicobacter pylori* and periodontal disease have also been identified as major risk factors of atherosclerosis (Scannapieco & Genco, 1999, Rosenfeld & Campbell, 2011). In addition, poor maternal health and low birth weight are further suspected to significantly increase the risk of developing atherosclerosis in adult life (Barker, 1998). Even though often considered a modern disease, some of these risk factors leading to advanced atherosclerosis were similarly present at Amara West. One of the major environmental risk factors is linked to dietary composition including high levels of fat, sugar and protein. Archaeozoological and archaeobotanical evidence indicates that people living at Amara West certainly had access to a diet that included meat, and sugar through dates (Ryan et al., 2012), and thus dietary factors potentially could have contributed to the risk of developing atherosclerosis.

Underlying infectious causes also have to be taken into account as well. All five individuals with calcified atheromatous plaques also had new bone formation on the visceral side of the ribs, providing evidence of chronic infection of the lung. Today, tobacco smoking is seen as the second most important cause of atherosclerosis (Lusis, 2000). Recent clinical studies indicate that habitual exposure to wood smoke can have detrimental effects on health, very similar to tobacco smoking (Danielsen et al., 2011).

Moreover, a link between atherosclerosis and bacterial pneumonia has also been established recently (Rosenfeld & Campbell, 2011). Even though the cause of new bone formation on the visceral surfaces of ribs of the individuals at Amara West remains unknown, it appears possible that it was at least partially linked to atherosclerosis affecting the individuals. In addition, all individuals showing evidence for arterial calcification also displayed signs of moderate or severe periodontal disease.

However, an underlying genetic predisposition cannot be excluded. Recent findings in mummies were used as an argument supporting a genetic background as the main reason for the development of atherosclerosis (Thompson et al., 2013). Moreover, Zink and co-workers (2011) suggested a genetic predisposition in Egyptian populations as an explanation for the high prevalence of advanced atherosclerosis in ancient Egyptian mummies Direct evidence for a genetic predisposition in past human populations has so far only been identified in the “Iceman” (Keller et al., 2012). Two of the individuals from Amara West with calcified plaques (Sk244-4, Sk244-6) were buried next to each other within the same grave. Even though it is currently impossible to prove familial ties with any certainty, this finding is nevertheless intriguing. While a genetic predisposition to atherosclerosis in Nile Valley populations is certainly within reason, much more research into the genetics or epidemiology of atherosclerosis in African countries and in other regions of the world in general, is needed in order to argue for or against this claim.

The medial arterial calcifications observed in individual Sk305-4 can be caused by diabetes, end-stage chronic kidney disease or old age (Towler, 2008). Extensive calcifications, also referred to as “railroad-track like” occurring in the peripheral arteries of the lower limbs are secondary pathological symptom in diabetes mellitus (Lehto *et al.*, 1996, Towler, 2008). Due to the fact that this disease does not cause any direct skeletal changes, the antiquity and paleoepidemiology of this disease are unknown (Aufderheide & Rodríguez-Martín, 1998: 343). Literary sources from Egyptian medical papyri have tentatively been interpreted as evidence for diabetes (Loriaux, 2006). Evidence from human remains is almost absent. Soft tissue changes ascribed to the disease have been noted in an Egyptian mummy (Marx & D'Auria, 1986). In addition, Dupras et al. (2010) report a Middle Kingdom individual from Dayr-el-Barsha (2055-1650BC) with a complex set of skeletal pathologies which they interpreted as potentially arising from diabetes. Therefore, the possibility that the individual may have suffered from diabetes is not without reason.

9.11. Developmental and congenital defects

Developmental or congenital defects comprise a wide range of different manifestations, with major differences as to their severity and impact on the functionality of the affected person (Barnes, 2012). A systematic assessment of developmental or congenital defects was not within the scope of this thesis. Nevertheless, no example of a developmental condition that would have impacted on the health of the individual was observed in the human remains from Amara West. Within the wider regional context, systematic palaeopathological analyses of Nubian populations have not focused on this category of diseases, or at least have not reported results. As a consequence, inferences about the paleoepidemiology of congenital and developmental conditions in ancient Nubia cannot be made, to date. Only a small number of isolated case reports exist. Armelagos (1969) reports a hydrocephalic child from Wadi Halfa dating between 350–550AD, several examples are known from Egypt (Nunn, 1996: 78–80). Amongst the developmental conditions, achondroplasia is the one most extensively documented, with several intact skeletons ranging in date between 4500 and 800BC (Dawson, 1938, Kozma, 2006). This is further complemented by over 200 known iconographic representations of “dwarfs”, attesting to the high social status and distinguished position they held in ancient Egyptian society (Nunn, 1996: 78). In Nubian sites, two isolated bones possibly representing achondroplasia were reported by Buzon (2004: 115)

Developmental and congenital defects have a wide range of different causes ranging from hereditary to environmental factors during neonatal development (Barnes, 2012). Interpreting their absence in the population from Amara West is therefore not straight forward but can only be seen as an indication that risk factors for disorders in this category were not present at Amara West.

9.12. Results of the stable isotope analysis

9.12.1. Diet at Amara West

Analysis of the carbon isotope ratio in tooth enamel provided several insights into the composition of diet at Amara West. The mean values of $\delta^{13}C$ are -12.93‰ and -12.90‰ in the New Kingdom and post-New Kingdom period, respectively. Modern Nubian C^3-plants known also to be present in ancient Nubia (Ryan *et al.*, 2012) have average $\delta^{13}C$ values of -26.5‰, while C_4-plants would range around -11.7‰ (White & Schwarcz, 1994). Based on the equation for diet–tissue spacing devised by Fernandes et al (2012), assuming an offset of +10.1‰ and taking into account the fossil fuel correction factor of 1.5‰, the limit for human tissue with a diet purely consisting of C^3- plants would be expected to be -14.9‰. The mean values for people living at Amara West are only ~2‰ more positive and therefore indicate a diet predominantly based on C_3-plants during both the New Kingdom and post-New Kingdom periods. This is generally consistent with the archaeobotanical record in the settlement at Amara West which similarly indicates an almost exclusive reliance on C_3-plants (Ryan *et al.*, 2012). Amongst the species most commonly identified in settlement deposits are emmer wheat and barley as the main cereals as well as several types of fruits and legumes such as sycomore fig, doum palm, colocynth, watermelons or lentils.

However, the slightly enriched $\delta^{13}C$- values of the inhabitants of Amara West also indicate a small proportion of C_4-derived carbon in the diet. This could either reflect actual consumption of C_4-plants by the inhabitants of Amara West but also consumption of animals with a C_4-diet. Differentiating between those two sources based on carbon isotopes alone is not possible (Lee-Thorp *et al.*, 2003). In the archaeobotanical record at Amara West C_4-grasses are only represented in the form of wild grasses, even though the quantities are very small which, so far, strongly argues against any economic importance of these grasses (Ryan *et al.*, 2012). The timing of the introduction of cultivated C_4-grasses such as millet and sorghum in Nubia is still unclear. The earliest evidence so far comes from Kawa and dates to the $6^{th}/7^{th}$ century BC (Fuller, 2004). Data from Tombos (Buzon & Bowen, 2010) and Kerma (Thompson *et al.*, 2008) indicate a certain contribution of C_4-plants to the diet of the individuals. Values are higher at Kerma, which was interpreted as a preference for local grasses by the local Nubian population. The lower $\delta^{13}C$ in Tombos hence was interpreted as an indication for a more Egyptian way of life with preferential use of C_3-plants (Buzon & Bowen, 2010). However, such interpretations seem problematic given that, based on carbon isotope ratios alone, it is not possible to infer whether the carbon was derived directly from plants or via consumed animals (Lee-Thorp *et al.*, 2003). Faunal samples from Amara West as well as from Kerma indicate a significant consumption of C_4-plants by sheep/goat as well as cattle. This is unsurprising since the local vegetation would have comprised a large amount of C_4-grasses which are also evident in the archaeobotanical record of Amara West (Ryan *et al.*, 2012). If livestock were left to graze in the vicinity of the settlement, those grasses would have contributed a major part of their fodder. If those animals were then consumed by the inhabitants of Amara West – and the large amount of faunal remains within settlement layers strongly indicates they did – it would have led to elevated $\delta^{13}C$-values.

In diachronic comparison, the mean $\delta^{13}C$ of -12.90‰ for the post-New Kingdom group is very similar to the New Kingdom group ($\delta^{13}C$=-12.93‰) and does not suggest any significant diachronic changes in diet over time. The small variability of the New Kingdom sample does not indicate any dietary differences between individuals in this time period even though the sample is rather small. The post-New Kingdom group generally shows a broader variability than the New Kingdom sample, ranging from -14.21‰ to -11.94‰. The sample contains a higher number of individuals with higher $\delta^{13}C$-values, indicating a trend towards incorporation of more C_4-plants, or animals feeding on them. The larger variability is particularly evident in the individuals from the niche burials, assumed to represent the latest stage of use of the cemeteries. In light of increasing aridity which presumably went alongside decreasing agricultural productivity, changes in dietary composition with less reliance on cereal products might be expected. It is well-evidenced that in drought areas subsistence can shift from agriculture to livestock herding (Geist, 2005: 71). Inferences about subsistence during the post-New Kingdom period remain difficult in the absence of settlement evidence, but it appears possible that the larger range in $\delta^{13}C$ could indicate higher variability of available food sources with a higher reliance on meat during periods of drought and crop failure.

9.12.2. Oxygen isotope data

9.12.2.i. Water consumption at Amara West

The main source of drinking water for people living in settlements along the Nile would have been the river and its channels (Butzer, 1976). The isotopic composition of the Nile results from the mixing of the oxygen values of the While Nile, the Blue Nile and the Atbara River. The contributions of the main tributaries vary according to levels of rainfall in the source regions, between 5% of the White Nile and 95% of the Blue Nile during peak times, while during low periods the ratio is 30% and 70%, respectively (UNESCO, 1995). The mean $\delta^{18}O$ of the White Nile near Khartoum was measured at 1.3‰, while the Blue Nile ranges around -1.5‰ (Malberg & Abd el Shafi, 1975). A more recent study produced values of 3.28‰ and 1.13‰ for the White and Blue Nile, respectively, and 2.51‰ for the main Nile in Khartoum (Farah *et al.*, 2000). Downstream from the confluence of the main Nile and the Atbara there are no major tributaries which could alter isotopic composition of the water. Precipitation in Nubia and Egypt has been very low since the end of the last Holocene wet phase (*c.* 6000BP) (Revel *et al.*, 2010), and therefore would also not have any significant input to oxygen isotope ratios. As a consequence, Nile water gets gradually enriched in ^{18}O as it flows north due to evaporation (Iacumin *et al.*, 1996a, Buzon & Bowen, 2010). The mean $\delta^{18}O$ of the Nile in Cairo was reported as 3.8‰ (Simpson *et al.*, 1987) even though Iacumin *et al.* (1996a) state (without indicating the source) a value of 2.3‰. The oxygen isotopic composition of the Nile during ancient times remains unknown. The existence of the palaeochannels surrounding the Nile indicates higher rainfall in the catchment areas of the Nile's tributaries (Woodward *et al.*, 2007), thus local $\delta^{18}O_W$ may have been different from modern values.

When applying the equation by Luz *et al.* (1984) to calculate mean $\delta^{18}O_W$ from the oxygen isotopic composition of the Amara West individuals, values of -0.1‰ and 1.5‰ were obtained for the New Kingdom and post-New Kingdom group, respectively. The equation devised by Daux *et al.* (2008), which was also applied by Touzaux *et al.* (2013), produced $\delta^{18}O_W$=1.0‰ for the New Kingdom and $\delta^{18}O_W$=3.0‰ for the post-New Kingdom group. While the values obtained by the first equation appear relatively low when compared to modern Nile data, the latter ones appear somewhat more plausible. Nevertheless, it has to be taken into account that both equations are based on $\delta^{18}O$ from phosphate, and thus in order to apply to the Amara West results the observed values of $\delta^{18}O_C$ first had to be converted using the calculation of Chenery *et al.* (2012). This introduces another possible source of error, and thus the results have to be viewed with caution. In addition, the equation has a relatively large uncertainty of ± 0.7 ‰.

Site		Date	No samples	Mean $\delta^{18}O_C$ (‰)	Min $\delta^{18}O_C$ (‰)	Max $\delta^{18}O_C$ (‰)	Sd	Reference
Antinopolis	Egypt	80–690BC	7	31.50	31.1	32.7	0.6	Touzeau *et al.*. 2013
Mendes	Egypt	80–690BC	35	31.10	29.8	31.5	0.9	Prowse *et al.*. 2007
Gournah	Egypt	80–690BC	7	31.50	28.7	33.9	1.6	Touzeau *et al.*. 2013
Gournah and Thebes	Egypt	282BC–5AD	11	31.10	30.4	33.0	0.7	Touzeau *et al.*. 2013
Gournah	Egypt	614–475BC	14	31.44	29.4	32.7	0.9	Touzeau *et al.*. 2013
Gournah	Egypt	1500–1035BC	7	30.59	29.6	31.9	0.7	Touzeau *et al.*. 2013
Deir el-Medineh	Egypt	1940–1730BC	4	31.25	29.4	32.4	1.3	Touzeau *et al.*. 2013
Asyut	Egypt	2120–1990BC	8	31.00	30.2	32.1	0.5	Iacumin *et al.*.1996
Gebelein	Egypt	2120–1990BC	6	31.4	30.6	31.9	0.5	Iacumin *et al.*.1996
Khozan	Egypt	2630–2130BC	4	29.40	28.4	30.6	0.9	Touzeau *et al.*. 2013
Gebelein	Egypt	4950–2950BC	5	31.60	31.0	32.3	0.6	Iacumin *et al.*.1996
Rhoda	Egypt	4000–3000BC	2	28.9	28.9	28.9	0	Touzeau *et al.*. 2013
Wadi Halfa	Nubia	500–1450AD	34	32.70	29.8	35.7	2.5	White *et al.*. 2003
Kulubnarti	Nubia	500–1450AD	68	33.7	32.1	36.1	2.3	Turner *et al.*. 2007
Amara West	Nubia	1070–800BC	24	33.26	36.22	33.26	1.5	this study
Amara West	Nubia	1300–1070BC	6	32.35	32.73	32.35	0.3	this study
Tombos	Nubia	1450–1070BC	31	31.40	29.2	35.3	1.5	Buzon & Bowen. 2009

Table 9.21: $\delta^{18}O_{VSMOW}$ values from archaeological human remains from Nile Valley sites

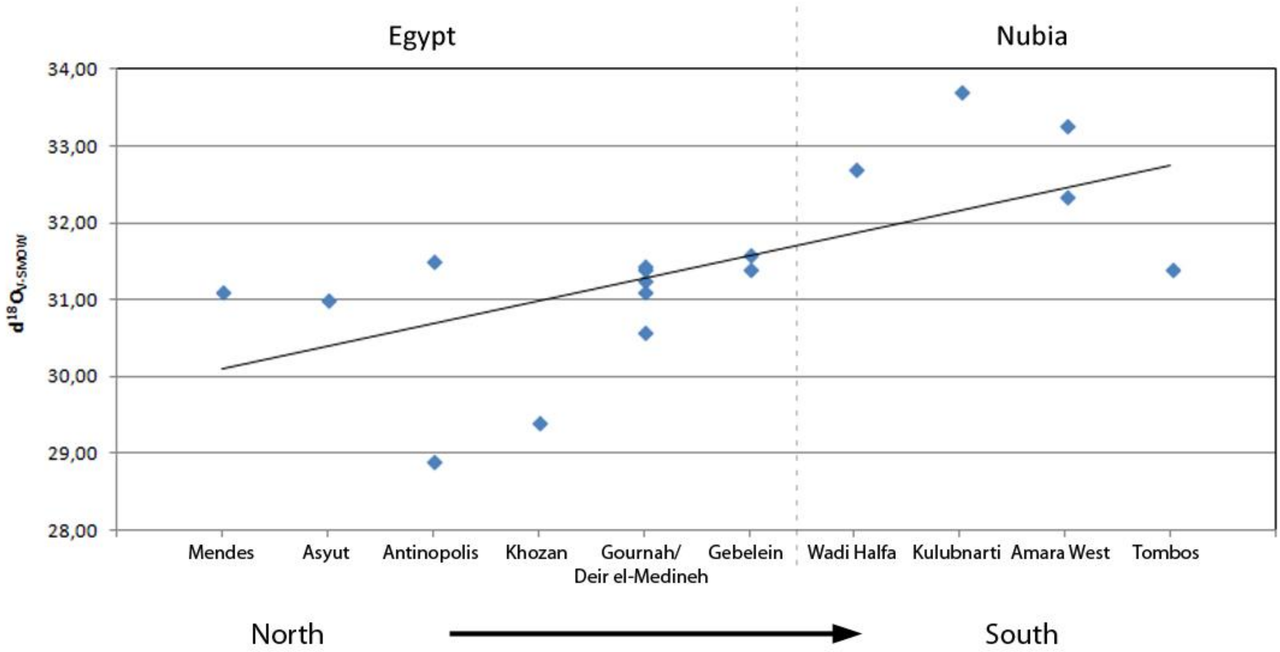

Figure 9.29 Geographic distribution of $\delta^{18}O_C$-values in Egyptian and Nubian sites (multiple points indicate multiperiod sites, data see Table 9.20)

In order to set the individuals from Amara West into a wider regional context the results were compared to other published data for archaeological human remains from Sudanese and Egyptian sites (see Table 9.21 and Figure 9.29). While the New Kingdom and post-New Kingdom groups from Amara West fall well into the range of Nubian populations, there are marked differences with Egyptian populations. When plotted in geographical order, $\delta^{18}O_C$-values (Figure 9.29), the results indicate an overall decrease in $\delta^{18}O$ with increasing distance from the source of the Nile, and the Nubian sites generally obtaining markedly higher values than the Egyptian sites. However, this represents the reverse to what would be expected under the premise that Nile water gets gradually enriched in $\delta^{18}O$ downstream. Several reasons could account for this apparent discrepancy.

One explanation could be sought in local differences in the isotopic composition of water sources used by Nubians and Egyptians, with higher and more variable values in Nubia. On the one hand this could indicate that factors other than evaporation are governing the $\delta^{18}O$ of Nile water resulting in local differences between Egypt and Sudan. As recharge from rainfall is insignificant, a decrease in $\delta^{18}O_W$ of the Nile downstream from the confluence of the White Nile and the Atbara could be the result of the influx from deep quaternary aquifers characterised by a low $\delta^{18}O_W$. For the majority of its length the Nubian and Egyptian Nile is underlain by the large Nubian aquifer which discharges into more shallow aquifers along the Nile (Thorweihe, 1990). The Nile has direct hydraulic interaction with its underlying aquifers forming a complex system of discharge and recharge (Dawoud & Ismail, 2013). Experimental models confirm that a certain amount of water from these aquifers discharges into the Nile (Dawoud & Ismail, 2013). Buzon & Bowen (2010) hypothesised that mixing due to discharge from shallow groundwater reservoirs during flood times has resulted in a decrease in $\delta^{18}O_W$ in the Egyptian part of the Nile. The aquifer system along the Nile comprises a number of different types of water bodies which also differ considerably in oxygen isotope composition. The water in the Nubian aquifer derives from precipitation during earlier Quaternary wet phases and therefore has very low $\delta^{18}O_W$-values (Thorweihe, 1990, Sultan *et al.*, 2007). In addition, there are also shallow alluvial aquifers which have provided elevated $\delta^{18}O_W$ with respect to the main Nile (Awad *et al.*, 1997). The exact distribution of contributions from those isotopically very different aquifers remains unknown, and consequently Buzon & Bowen's hypothesis remains unproven. In the absence of data, the possibility of similar processes taking place in the Sudanese part of the Nile cannot be excluded (Farah *et al.*, 2000, Omer, 2013).

Another possible explanation for the observed differences between Egyptian and Nubian samples may lie in cultural differences in the use and storage of water. In stagnant water, evaporation leads to increasing enrichment in ^{18}O. Water storage in large jars (*zirs)* is likely to have been commonplace in houses at Amara West: impressions of jar-stands in mud floors are often found beside low mastaba-benches (Spencer, pers. comm., 2013). Similar practices can still be seen in Nubia today. However, the use of *zirs* has also been widespread in ancient Egypt (Kemp & Stevens, 2010b). Nevertheless it remains possible that cultural practices and differences in length of storage would have resulted in the observed differences. In addition, the use of drinking water sources other than the Nile in Egypt has to be considered as a possible explanation of the observed differences, and the construction of wells and use of local groundwater is evident in ancient Egypt (Franzmeier, 2007). At Amara West, a well was identified by the EES even though it was never recorded properly (Spencer, 1997: 203). Nevertheless, this well would have sourced water from a shallow Nile acquifer fed by water from the main Nile with a similar isotopic signature. The addition of groundwater from aquifers along the edges of the flood plain with a lower $\delta^{18}O_W$ than the main Nile to drinking water in Egypt could have decreased oxygen isotope ratios in human tissue and could also serve as an explanation for lower values observed in Egyptian populations.

At Amara West, the presence of water highly enriched in ^{18}O is indicated by the very high values obtained from teeth of sheep and cattle from the New Kingdom settlement at Amara West, which are up to 8‰ higher than the average human values. These values point to water being predominantly consumed from stagnant water bodies including troughs/containers placed by humans e.g. in houses. Geomorphological evidence suggests that the palaeochannel north of the river was only intermittently flowing during the New Kingdom period. Receding water tables of the main Nile during the winter months would have first caused a decrease in water flow and eventually loss of connection of the palaeochannel to the main channel of the Nile. Due to evaporation, this would have consequently resulted in enrichment in ^{18}O. If these water sources were used as a source of drinking water for animals left to graze in the surroundings of the town it may have led to the very high values observed in the Amara West population.

Another notable feature of Nubian populations in general is the large variability in the observed values. This corresponds to observations made by other researchers investigating the oxygen isotopic composition in Nubian archaeological populations who have all noted the large range of values in their respective populations (White *et al.*, 2004, Turner *et al.*, 2007, Buzon & Bowen, 2010). One possible explanation may be the presence of more non-local people with high $\delta^{18}O$ in Nubian populations, which has also been suggested by Buzon & Bowen (2010). However, the aquifers providing groundwater in the desert regions of Northern Sudan are generally characterised by a very low $\delta^{18}O_W$ (Abdalla, 2009). Analysis of $\delta^{18}O_C$-values in bone and teeth of inhabitants of the Dakhleh Oasis in Egypt, with the main water source assumed to be derived from quaternary aquifers produced values of -28.4‰ corresponding with $\delta^{18}O_W$ of -5.9‰ (Dupras & Schwarcz, 2001). Thus, incomers from the desert regions in the vicinity would equally be expected to show low oxygen isotope ratios rather than high ones. However, Nubian groups are generally characterised by very high $\delta^{18}O$, and therefore the presence of non-locals in the population cannot account for the variability in the higher ranges.

Year-to-year-variation in the contribution of water from the White and the Blue Nile may also further lead to variability of isotopic composition of the main Nile. As has been stated above, the White and Blue Nile have very different oxygen isotopic signatures. Contributions of both sources can be subject to considerable variability depending on climate and rainfall in the source regions. With increasing enrichment through evaporation and contribution through local aquifers, this effect could be evened out further downstream and provide an alternative explanation for the higher variability in Nubian populations when compared to Egyptian groups.

White et al. (2004) further suggested that the variability may result from fractionation differences caused by pathological conditions, particularly osteopenia, but also anaemic conditions. Nothing is known about the health status of the Egyptian individuals included in the published isotope studies. However, in light of historic sources and the large amount of palaeopathological studies attesting to generally high levels of disease present in ancient Egypt (Buikstra *et al.*, 1993, Davies & Walker, 1993, Nunn, 1996), it appears unlikely that the higher variability in Nubian samples is a reflection of poorer health.

9.12.2.ii. Diachronic trends in oxygen isotope ratios at Amara West – Indications for climate change?

The mean δ^{18}O-values of the New Kingdom and post-New Kingdom samples show a statistically significant increase during the post-New Kingdom period. This difference requires further exploration. One explanation may lie in the presence of non-local people during the post-New Kingdom period. Archaeologically, there is no indication of any major migration or population replacement at Amara West during the post-New Kingdom period. Funerary ritual and material culture evidenced in the grave remains remarkably stable during the first part of the post-New Kingdom period. At some point during the 10^{th}/ 9^{th} century there is a shift in grave architecture, with chamber tombs being replaced by smaller niche burials. However, other aspects of funerary culture such as body position and choice of grave goods remain unchanged, and the presence of transitional graves such as G211 in Cemetery D suggests gradual change rather than population replacement. Isotopically, individuals buried in niche graves have very similar values to those buried in the chamber tombs. Therefore, neither archaeological nor isotopic data would support the idea of non-local people being present at Amara West. Only one sample lies significantly outside of the range. AW33 is a sample from a disturbed deposit of windblown sand in the shaft and upper layer of the western burial chamber of the post-New Kingdom tomb G243 (context [9282]). Even though the exact position and context of the individual is unclear, it remains possible that the burial represents a later intrusion. The significantly lower $\delta^{18}O_{enamel}$-value of 28.55% corresponding with $\delta^{18}O_w$ of -5.56‰ (using the equation of Daux *et al.*, 2008) excludes the Nile as the main water source of drinking water. It rather points towards an origin in the desert regions with fossil water from the Nubian aquifer as the main source of drinking water. The presence of this individual may therefore indicate the presence of desert nomads at Amara West during the post-New Kingdom period.

Alternatively, the increase in $\delta^{18}O$ during the post-New Kingdom period could be a reflection of the environmental changes affecting the region during the early 1st millennium BC (Spencer *et al.*, 2012). Applying the equation of Daux *et al.* (2008), $\delta^{18}O_w$ of ingested water on average increased by 1.6‰ which would be consistent with a significant shift towards more arid conditions occurring during the post-New Kingdom period. The data from Amara West also corresponds well with the results of Touzeau and co-workers (2013) who detected a gradual increase from -1.6‰ to +1.5‰ $\delta^{18}O_w$ in Egyptian mummies between the Predynastic and Coptic Period (4000BC–500AD) and attributed this to general aridification in the entire Nile Valley region.

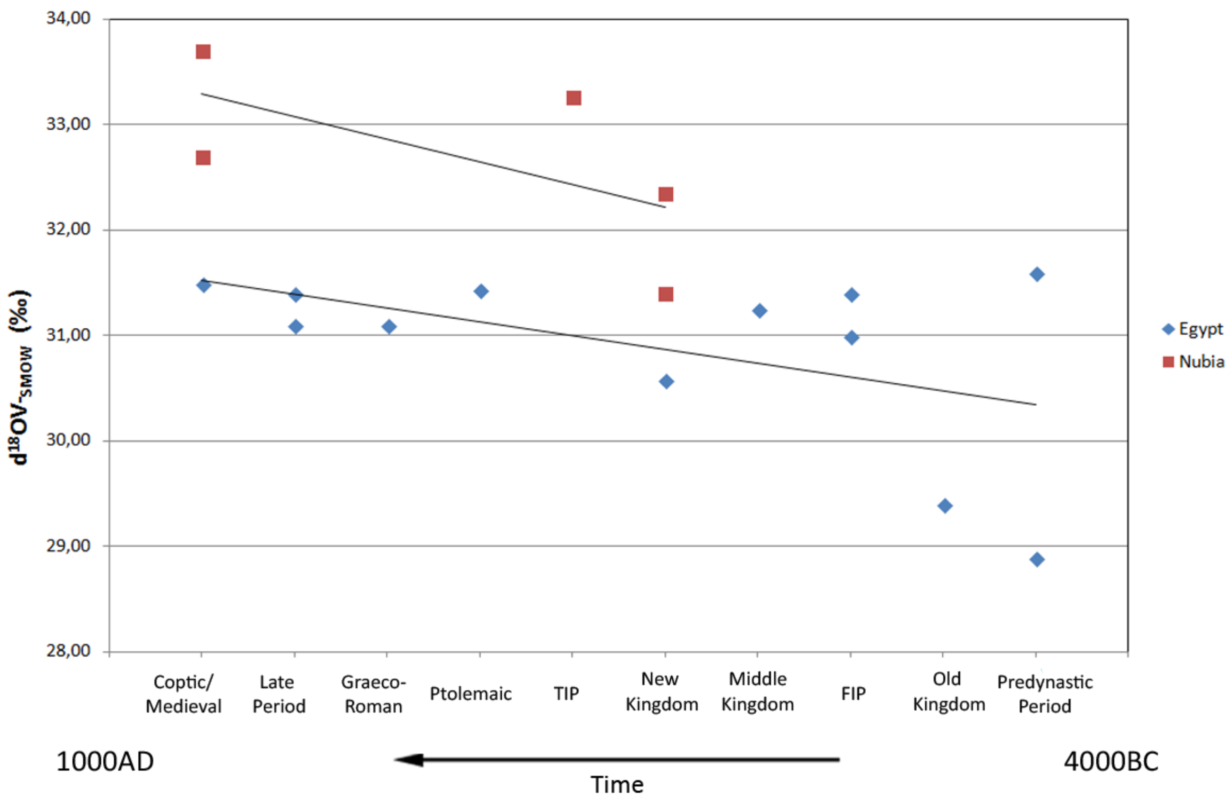

Figure 9.30 $\delta^{18}O_C$-values from Nile Valley sites in chronological order (TIP=Third Intermediate Period, FIP=First Intermediate Period)

When plotting data from Egyptian and Nubian sites in chronological order (see Figure 9.30), the diachronic trend towards higher values becomes evident both in Egypt and Nubia. These data suggests a general increase in $\delta^{18}O_W$ of the main Nile which may be one explanation for the observed shift in oxygen isotope ratios of enamel carbonate at Amara West. Support for the hypothesis of increasingly arid conditions during the later 2nd and early 1st millennium BC comes from geomorphological data from Amara West. These indicate a general decrease in Nile floods which locally led to the drying out of the palaeochannel immediately to the north of Amara West, as well as another branch of the Nile further out in the desert (Spencer *et al.*, 2012). Increasing aridity, lower flood levels together with higher temperatures and decreasing local humidity would have also affected $\delta^{18}O$ of Nile water leading to more evaporation and consequent enrichment in ^{18}O. The cessation of the palaeochannels would have further decreased local humidity which would have additionally added to the enrichment.

Certain metabolic diseases, particularly osteopenia have also been shown to have an influence on the oxygen isotopic composition of human tissue (White *et al.*, 2004). The samples analysed in the population from Amara West derive both from articulated and disarticulated individuals. In the articulated skeletons no obvious signs of disease that could account for the diachronic differences, but also the variability in $\delta^{18C}C$ in tooth enamel, were observed. For the disarticulated individuals no such information could be obtained. Thus, an underlying pathological influence on isotopic composition cannot be excluded. However, the differences were not statistically significant, and therefore it remains questionable whether the small pathologically induced alterations would be sufficient to account for the considerable diachronic differences observed between the New Kingdom and post-New Kingdom populations at Amara West.

Chapter 10. Conclusions

10.1. Summary of findings

10.1.1. Demography

Comparison of the demographic profiles of the New Kingdom and post-New Kingdom populations did not show any significant differences between the two groups. In both time periods, the numbers of young adults is relatively higher than old and middle adults. This suggests a relatively high level of environmental pressures affecting people throughout the time period of occupation of Amara West. The main difference in demographic structure is the absence of infants in the New Kingdom sample while in the post-New Kingdom group they account for 35.5% of the population. However, this is likely to be explained by differences in funerary practice. Within the sub-adult sample of the post-New Kingdom period, the presence of older children points towards a high degree of infectious pathogens present in the environment of Amara West.

10.1.2. Growth

Growth was assessed using adult femur length, stature and sub-adult growth profiles. Only a small number of individuals could be included for this area of analysis due to the high amount of fragmentation affecting the long bones of skeletons at Amara West. Consequently, the results are not necessarily representative. While the results of stature estimation fit well into the general spectrum of archaeological groups from Sudan, the people are significantly smaller than modern Egyptian and Sudanese populations. Femur lengths of the post-New Kingdom population further indicate a low stature for the people living at Amara West and potentially indicate disturbances of growth brought about by malnutrition and diseases. Comparison of long bone length of post-New Kingdom sub-adults with modern growth standards showed significant growth deficits, and therefore lending further support to the notion of challenging living conditions during the post-New Kingdom period.

10.1.3. Dental Disease

Dental health was poor for all people living at Amara West throughout the time period of occupation. This becomes particularly evident when comparing results from Amara West to other Nile Valley sites. Amongst the main reasons accounting for the poor health status of teeth are a high degree of grit and sand in the diet leading to attrition and dental diseases such as periapical lesions and caries. A statistically significant increase in the prevalence of caries, periapical lesions and AMTL in young adults during the post-New Kingdom period indicates alterations in the composition of the diet and/ or an increase in the amount of abrasive material in the diet, perhaps together with an overall decreased immune defence resulting from a general deterioration of living conditions. The reverse trend could be observed with regard to dental calculus, with a significantly higher prevalence during the New Kingdom period. This further supports dietary differences between the New Kingdom and post-New Kingdom period even though the underlying reasons remain speculative in the absence of intact settlement deposits dating to the later period. The prevalence of dental enamel hypoplasia significantly increased during the post-New Kingdom period, providing further evidence for considerable changes in the living environment at Amara West.

10.1.4. Orbital lesions

Orbital lesions were generally common in both time periods. Significant changes were observed in the degree of expression, potentially indicating differences in the underlying reasons leading to formation of orbital lesions. However, due to the unclear aetiology of this category of pathological changes, the underlying reasons and any differences with regard to their manifestation can only be speculated upon. Based on the environmental context of the population, potential reasons include anaemia, particularly due to malaria, infectious diseases of the eye, but also scurvy.

10.1.5. Infectious diseases

New bone formation (NBF) in the long bones, on the visceral side of the ribs, in the maxillary sinuses, and on the endocranial side of the skull, provide evidence of inflammatory diseases of different, non-specific origin was also very frequently observed in both groups. Comparison of results from the people living at Amara West with other Nile Valley populations supports the notion that the burden of inflammatory conditions was relatively high. NBF in the long bones increased significantly during the post-New Kingdom period, even though the underlying reasons remain unknown due to the wide host of potential causes. The high prevalence of NBF on the ribs and maxillary sinuses indicates that respiratory diseases represented another very common health problem at Amara West throughout the time of occupation. This notion gains further support when comparing the results with other archaeological sites worldwide. A significant increase in NBF in the ribs during the post-New Kingdom period indicates an increase in the factors leading to chronic respiratory diseases, and may be linked to a higher burden of environmental pollution in the wake of general environmental deterioration. Evidence for specific infectious diseases such as TB was not observed at Amara West. Nevertheless, it is possible that TB accounts for a least a certain proportion of the observed prevalence of chronic inflammatory diseases of the lungs because the environmental context would have certainly supported the presence of TB. Changes on the endocranial side of the skull vault represented another common palaeopathological finding in the population from Amara West. The overall increase during the post-New Kingdom period again supports the notion of increasing environmental stress occurring during the later stages of occupation of Amara West.

10.1.6. Diseases of the joints

The prevalence of osteoarthritis in the spine and extra-spinal joints, together with intervertebral disc disease (IVD) was high in both temporal groups. Age-controlled analysis showed that young adults already suffered from osteoarthritis and IVD. These findings indicate a physically highly demanding environment, potentially in relationship to an agricultural subsistence and associated activities of everyday life, such as manufacture and maintenance of infrastructure throughout the time of occupation of Amara West. Diachronic comparison only indicates a slight increase in degenerative joint diseases during the post-New Kingdom period, but a statistically significant difference was only observed in the shoulder joint. Even though these changes could indicate increasing intensity of labour due to a deteriorating agricultural potential and increasingly challenging maintenance of the settlement, this has to be viewed with caution given that the differences are insignificant and may be somewhat biased due to the smaller sample size of the New Kingdom group.

10.1.7. Trauma

High levels of fractures were also observed in the people from Amara West, particularly in the spine and forearms, but also in more unusual locations such as the scapulae and pelvis. The majority of fractures appear related to indirect, high-impact trauma, such as occurring in fall-related accidents or high-velocity impact from moving objects. Based on the archaeological and environmental context, activities of daily life including tending of trees and handling of livestock, but also architectural features such as upper storeys may be identified as the main sources of accidents. The diachronic comparison showed an overall increase in fracture prevalence during the post-New Kingdom period. This indicates changes in the exposure to risk factors leading to fractures and might reflect changes in subsistence strategies.

10.1.8. Miscellaneous conditions

Even though not assessed systematically, a number of other diseases were observed in the skeletal remains, adding further information about the general spectrum of health and disease at Amara West. Amongst the New Kingdom population, ossifications in the spine in a middle adult man from Cemetery D were diagnosed with DISH, while a young adult man buried in Cemetery C showed evidence of metastatic carcinoma. In the post-New Kingdom group, four individuals displayed pathological lesions in the feet that may be attributed to gout. A middle adult male in Cemetery C likely suffered from ankylosing spondylitis, evidenced through extensive ossification of the sacro-iliac joint and spine. Calcifications associated with two New Kingdom and three post-New Kingdom individuals may be interpreted as calcified arterial plaques caused by advanced atherosclerosis.

10.1.9. Stable isotope data

This study also included analysis of stable carbon and oxygen isotopes from bioapatite in dental enamel. Initial plans to incorporate dietary reconstructions based on carbon and nitrogen isotopes had to be discarded due to poor preservation of collagen in bone and dentine. Comparison of $\delta^{13}C$-ratios indicates a diet mainly based on C_3-plants which is consistent with the archaeobotanical record from Amara West. The oxygen isotopic composition of dental enamel provides evidence for severe environmental alterations during the post-New Kingdom period. It further indicates that the transition to niche burials in the later phase of occupation of Amara West was likely not related to population replacement.

10.2. Limitations of the data

Interpretation of data and any inferences about living conditions at Amara West were limited by two main factors: preservation and diagnostic limitations of palaeopathological changes. One major problems concerns preservation and the representativeness of the sample. Unfortunately the number of individuals available for study dating to the New

Kingdom was very small, a problem that was particularly evident in age-controlled comparisons. It is anticipated that future field work will increase the size of the New Kingdom sample and may help to further refine our knowledge about health and living conditions during the New Kingdom.

Many of the pathological changes observed in the people from Amara West have to remain non-specific in aetiology or can only be assigned to very broad categories. This is unfortunate because a more precise diagnosis may potentially significantly alter the picture of health status of the people gained through the skeletal analysis. However, these diagnostic shortcomings are inherent to palaeopathological research in general, and without the application of destructive techniques or refinement of existing methods will be impossible to resolve. Nevertheless, the study highlights the importance of contextual data and shows that a thorough consideration of the archaeological and environmental background can add valuable information to the study of disease in the past and may at least partially compensate for methodological shortcomings.

10.3. Revisiting the hypotheses

10.3.1. Hypothesis 1: Political and cultural change

Hypothesis 1 outlined in the introduction of this thesis stated that the end of Egyptian colonial control lead to a cessation of the imports and provision of goods from Egypt itself and also led to a disruption of the socio-economic structure of the community which had a negative influence on health of the people living at Amara West. In the absence of intact occupation deposits dating to the post-New Kingdom period inferences about subsistence and socio-economic structure of the community are difficult to make. However, a transition from a planned towards a self-organised and heterogenous settlement is already evident throughout the New Kingdom, thus it remains questionable as to what extent the end of colonial control would have had any significant socio-economic consequences at all. Archaeological evidence from the cemeteries indicates a certain degree of cultural changes occurring during the post-New Kingdom period, manifested through an increase in Nubian funerary practices and a shift in tomb architecture. However, the layout and furbishing of the tombs so far does not support the idea of significant socio-economic decline.

Nevertheless, the structural changes within the town occurring perhaps as a result of decreasing state involvment attest to an increased population density and increasingly crowded living conditions from *c.* 1200BC onwards. These changes would have facilitated higher levels of pathogen load and their impact on community health may be reflected in the increase in potential evidence of non-specific infectious diseases including bilateral NBF in the tibiae and fibulae as well as endocranial lesions. The diachronic comparison of patterns of osteoarthritis does not indicate significant changes in subsistence strategies or intensity of labour but rather argues for a labour-intensive lifestyle throughout the time of occupation of the settlement. Certain changes in composition of the diet leading to an increase in dental pathologies may be related to cultural preferences but, again, this is difficult to ascertain in the absence of contemporary contextual evidence. In summary, even though certain diachronic changes potentially support Hypothesis 1, there is currently not enough evidence to clearly establish a link between the decline in health and the political and cultural changes alone.

10.3.2. Hypothesis 2: Climatic change

Hypothesis 2 states that climatic changes occurring in the region at the end of the 2nd and beginning of the 1st millennium BC had an impact on the health of the people living at Amara West. Palaeoenvironmental and micromorphological research at the settlement and surrounding landscape at Amara West has revealed a number of indications that the environment of the town underwent significant changes related to general aridification and a decline of Nile floods. From a bioarchaeological perspective, the notion of aridification during the post-New Kingdom period is further supported by the results of stable oxygen isotope analysis. The significant increase in $\delta^{18}O$ during the later period likely reflects increased evaporation in Nile water through higher temperatures and an overall decline of floods. Bioarchaeological data indicates diachronic changes in several indicators of health analysed in this study which may reflect this environmental deterioration. The overall increase in the prevalence of respiratory diseases at Amara West is consistent with observations in modern populations living in areas affected by droughts and aridification (Stanke *et al.*, 2013). The rise in NBF in the tibiae possibly indicates an increased burden of infectious agents during the later period. Drought-related diseases such as scurvy evident in sub-adult remains of the post-New Kingdom period further support the notion of food shortages even though, in the absence of a comparative New Kingdom sample, it remains unclear to what degree this is unique to the later stages of occupation of the settlement. Higher rates of dental enamel hypoplasia together with a low stature are further consistent with an increasing scarcity of resources. Consequently, the results of the bioarchaeological analysis support the hypothesis, that climatic changes had an impact on health and living conditions of the people living at Amara West. They also provide further evidence to support the idea that the abandonment of Amara West was related to environmental reasons which left life on the north bank of the Nile unsustainable at some point in the early 1st millennium BC.

10.4. Significance and outlook

The contextualised bioarchaeological analysis of the skeletal human remains from Amara West has revealed insights into health and living conditions of a community in a marginal environment, at the fringes of the Egyptian empire but also in an environmental sense at the fringes of an habitable environment. Palaeopathological results indicate that the people at Amara West were already faced with a challenging environment from the initial stages of the settlement onwards, and it deteriorated further over the time span of occupation – not simply from the period when the pharaonic state lost political control of the area. Climate change has been identified by the WHO as one of the major health threats of the 21st century (WHO, 2013c). Despite its relevance to modern populations, the impact of climate change on health has so far only very rarely been addressed from a bioarchaeological perspective (Roberts, 2010). However, bioarchaeology has the potential to reveal long term perspectives on the complex interactions between climate and human health as well as responses to climatic deterioration, and potentially help to fill gaps in modern medical research. At ancient Amara West, the bioarchaeological results indicate a deterioration of the overall health status of the people which may be linked to severe environmental changes.

This study presents conclusive evidence linking processes of abandonment to changes in climate and human health, and therefore also showcases the potential of bioarchaeological studies for informing broader archaeological and historical research questions. The knowledge obtained from this study could be expanded to other geographical regions or time periods in order to investigate broader patterns of human health in relationship to climate change. This may elucidate how, and in what way, cultural context, and socio-economic status or level of social organisation, influence response and vulnerability to climate change, but also how and what strategies and defense mechanisms are developed. Ultimately, climate change represents one of the major driving factors of human evolution and history, not less so because of its impact on human health. Understanding this complex relationship represents a crucial element of gaining a better understanding of our past.

The presence of diseases such as cancer or atherosclerosis, assumed to be modern diseases, in the population of Amara West further raises interesting questions about general theoretical concepts of disease transitions. Both cancer and atherosclerosis represent key features of the 2nd epidemiological transition. This transition, commencing with the start of industrialisation is associated with improved living conditions and characterised by a decline in mortality through infectious diseases and a corresponding rise in chronic non-infectious and degenerative disease (McKeown, 2009). The earlier, 1st epidemiological transition occurred with the transition to agriculture and related increases in infectious diseases, while currently the world finds itself in the 3rd epidemiological transition (the re-emergence of infectious diseases, and new infections along with resistance to antibiotics). The presence of modern diseases in a pre-transitional population raises doubts about this theoretical concept and highlights the fact that cancer as such is not only linked to longevity but also to infectious diseases. This further indicates that the boundaries between the 1st and 2nd transition may not be as clear-cut as previously thought (Esche et al., 2010).

Health and Diet in Upper Nubia through Climate and Political Change

A bioarchaeological investigation of health and living conditions at ancient Amara West between 1300 and 800BC

2 Volumes

Volume II – Appendices and Plates

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PhD Thesis
Department of Archaeology
Durham University
2014

Table of contents

Amara West	Cemetery:	Grave:	Individual:	Date:

Summary

Age:

Sex:

Stature:

Pathologies:

Additional analysis/ Sampling:

Complete Disturbed Isolated Element Commingled Context

Single Multiple

Bone preservation

Overall Bone Preservation Score

1. Class 1: 0% of sound cortical surface
2. Class 2: 1-24% of sound cortical surface
3. Class 3: 25-49% of sound cortical surface
4. Class 4: 50-74% of sound cortical surface
5. Class 5: 75-99% of sound cortical surface
6. Class 6: 100% cortical surface completely sound

Overall Preservation

1. Excellent: solid bone, no or little breakage or erosion
2. Good: some breakage
3. Fair: some pieces of bone missing
4. Poor: most elements broken with pieces missing, cracks, splingering and bone surface is rough
5. Fragments: all bones are friable, splintered or very fragmentary, extreme weathing, little identifia tion possible
6. Other:

Soft tissue:

Amara West	Cemetery:	Grave:	Individual:	Date:

Sex:

Feature	Weight W	Value
Cranium		
Glabella	3	
Arc. superciliaris	2	
Tub. frontalia u. pariet.	2	
Inclinatio frontalis	1	
Proc. mastoideus	3	
Relief Planum nuchale	3	
Protub. occ. ext.	2	
Proc. zygomaticus	3	
Os zygomaticum	2	
Crista supramast.	2	
Margo supraorbitalis	1	
Mandibula		
Appearance	3	
Mentum	2	
Angulus	1	
Margo inferior (M2)	1	
Angle	1	
Pelvis		
Sulc. praeauricularis	3	
Inc. isch. maj.	3	
Angulus pubis	2	
Arc. composé	2	
Os coxae	2	
For. obturatum	2	
Corpus ossis ischii	2	
Crista iliaca	1	
Fossa iliaca	1	
Pelvis major	1	
Auricular area	1	
Sacrum	1	
Robusticity		
Humerus	1	
Femur	1	
Total		

Age:

Endocranial Suture Closure (Sjovold 1975)				
S1:	S2:	S3:	S4:	
C1: /	C2: /	C3: /	Age:	
L1: /	L2: /	L3: /		
Ectocranial Suture Closure (Rösing 1977)				
S1:	S2:	S3:	S4:	
C1: /	C2: /	C3: /	Age:	
L1: /	L2: /	L3: /		
Tooth Abrasion (Brothwell 1981)				
	M1:	M2:	M3:	
Max.				
Mand.				
			Age:	
Facies symphysialis (Suchey & Brooks 1990)				
Stage:			Age:	
Clavicula. Fac. art. sternalis (Szilvassy 1977)				
Stage:			Age:	
Ilium auricular surface (Lovejoy et al., 1985)				
Stage:			Age:	
Final Epiphysal Closure				
Other Observations:				

Amara West	Cemetery:	Grave:	Individual:	Date:

Inventory

Skull

0 = absent, 1 = < 25%, 2 = 25-75%, 3 = > 75%, 4 = complete

Frontal	
Occipital	
Sphenoid	
Ethmoid	
Vomer	
Cricoid	
Thyroid	
Hyoid	

	R	L		R	
Orbits			Malleus		
Parietal			Incus		
Temporal			Stapes		
Lesser wing					
Greater w.			**Juvenile Skull**		
Maxilla			Frontal: halves		
Nasal			Temporal bone: pars squama		
Zygomatic			Temporal bone: pars petrosa		
Palate			Occipital bone: pars squama		
Inferior conchae			Occipital bone: pars lateralis		
Mandible			Occipital bone: pars basilaris		
M. condyl					
TMJ					

Postcranium

0 = absent, 1 = < 25%, 2 = 25-75%, 3 = > 75%, 4 = complete

	R	L
Scapula		
Scap. acromio-		
Scap. glenohumeral		
Ischium		
Illium		
Pubis		
Acetabulum		
Auricular surface		
Patella		
Manubrium		
Sternum		
Xiphoid		

Clavicle					
	prox. Epiphysis	P 1/3	M 1/3	D1/3	dist. Epiphysis
right					
left					

RIBS

RIGHT	Head	Shaft	Stern.	complete
1st				
2nd				
11th				
12th				
3-10 (no)				

LEFT	Head	Shaft	Stern.	complete
1st				
2nd				
11th				
12th				
3-10 (no)				

Amara West	Cemetery:	Grave:	Individual:	Date:

Spine

	Complete	Body	Arch R	Arch L
C1				
C2				
C3				
C4				
C5				
C6				
C7				
Th1				
Th2				
Th3				
Th4				
Th5				
Th6				

	Complete	Body	Arch R	Arch L
Th7				
Th8				
Th9				
Th10				
Th11				
Th12				
L1				
L2				
L3				
L4				
L5				
Addi-tional?				
Sacrum				

Long bones

RIGHT	P. JS	P 1/3	M 1/3	D1/3	D. JS
Humerus					
Ulna					
Radius					
Femur					
Tibia					
Fibula					

LEFT	P. JS	P 1/3	M 1/3	D1/3	D. JS
Humerus					
Ulna					
Radius					
Femur					
Tibia					
Fibula					

Joint surfaces

	R	L
Humerus: glenohumeral		
Humerus: capitulum		
Humerus: trochlea		
Humerus: med. epicondyle		
Humerus: lat. epicondyle		
Ulna: trochlear notch		
Ulna: radial notch		
Ulna: distal radioulnar		
Radius: articular fovea		
Radius: circumferential art.		
Radius: distal radioulnar		
Radius: scaphoid (lat.)		
Radius: lunate (mesial/ulna)		

	R	L
Femur: head		
Femur: femoropatellar		
Femur: medial femorotibial		
Femur: lateral femorotibial		
Patella: femoropatellar		
Fibula pro. tibiofibular		
Fibula talofibular		
Tibia: lateral femorotibial		
Tibia: medial femorotibial		
Tibia: proximal tibiofibular		
Tibia: talocrural		

Amara West	Cemetery:	Grave:	Individual:	Date:

	right	left	indif
HAND			
Scaphoid			
Lunate			
Triquetral			
Capitate			
Hamate			
Trapezoid			
Trapezium			
Pisiform			
Metacarpal 1			
Metacarpal 2			
Metacarpal 3			
Metacarpal 4			
Metacarpal 5			
unassigned			
Prox. phals (No.)			
Mid phals (No.)			
Distal phals (No.)			
Sesamoid bones?			

	right	left	indif
FOOT			
Calcaneus			
Talus			
Navicular			
Cuboid			
Medial cuneiform			
Internal cun.			
Lateral cun.			
Metatarsal 1			
Metatarsal 2			
Metatarsal 3			
Metatarsal 4			
Metatarsal 5			
unassigned			
Prox. phals (No.)			
Mid phals (No.)			
Distal phals (No.)			
Sesamoid bones?			

Amara West	Cemetery:	Grave:	Individual:	Date:

Postcranial Measurements

		Right	Left
Femur			
FeL1 (Max. length)	F1		
FeL2 (Oblique length)	F2		
FeD1 (A-P min. diam)	F10		
FeD2 (M-L min. diam)	F9		
FeD5 (Max. diam. head)	F15		
C (Mid shaft circ.)	F8		
FeE1 (Bicondylar width)	F21		
Tibia			
TIL1 (Max. length)	T1a		
(Complete length)	T1		
TiE1 (Bicondylar width)			
TiD1 (A-P diam.nut.for)	T8a		
TiD2 (M-L diam.nut.)	T9a		
Fibula			
FiL1 (Max. length)	Fi1		

		Right	Left
Humerus			
HuL1 (Max. length)	H1		
HuD5 (Max. diam. head)	H9		
Max. epicondylar width	H4		
Radius			
RaL1 (Max. length)	R1		
Ulna			
UlL1 (Max. length)	U1		
Clavicle			
ClL1 (Max. length)	C1		
Scapula			
GC1 (Glen. cav. length)	S2		
GC2 (Glen. cav. width)	S2		
Atlas			
AW (Max. int. width)			
Sternum			
SL (Max. length body)			
ML (Max. length manub)			
Sacrum			
SacL (Max. length)			
SacB (Max. breadth)			

Indices

	Right	Left
Platymeric		
Platycnemic		
Radio-humeral (RaL1/HuL1) X 100 HuL1		
Femoral (FeD3 + FeD4) X 100 /FeL2		
Humeral (HC X 100/ HuL1)		

Amara West	Cemetery:	Grave:	Individual:	Date:

Postcranial Measurements

		Right	Left
Femur			
FeL1 (Max. length)	F1		
FeL2 (Oblique length)	F2		
FeD1 (A-P min. diam)	F10		
FeD2 (M-L min. diam)	F9		
FeD5 (Max. diam. head)	F15		
C (Mid shaft circ.)	F8		
FeE1 (Bicondylar width)	F21		
Tibia			
TIL1 (Max. length)	T1a		
(Complete length)	T1		
TiE1 Bicondylar width)			
TiD1 (A-P diam.nut.for)	T8a		
TiD2 (M-L diam.nut.)	T9a		
Fibula			
FiL1 (Max. length)	Fi1		

		Right	Left
Humerus			
HuL1 (Max. length)	H1		
HuD5 (Max. diam. head)	H9		
HC (Mid shaft circ.)	H7a		
Radius			
RaL1 (Max. length)	R1		
Ulna			
UlL1 (Max. length)	U1		
Clavicle			
ClL1 (Max. length)	C1		
Scapula			
GC1 (Glen. cav. length)	S2		
GC2 (Glen. cav. width)	S2		
Atlas			
AW (Max. int. width)			
Sternum			
SL (Max. length body)			
ML (Max. length manub)			
Sacrum			
SacL (Max. length)			
SacB (Max. breadth)			

Indices

	Right	Left
Platymeric		
Platycnemic		
Radio-humeral (RaL1/HuL1) X 100 HuL1		
Femoral (FeD3 + FeD4) X 100 /FeL2		
Humeral (HC X 100/ HuL1)		

Amara West	Cemetery:	Grave:	Individual:	Date:

Dental Recording Form

R	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	L
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	

0 = jaw not present
1 = tooth present
2 = lost PM
3 = lost AM
4 = broken PM
5 = root only
6 = congenital absent
7 = not erupted
8 = isolated tooth

Pathology and Dental Wear

	Right								Left							
Calculus																
Parodontitis																
DEH type																
DEH severity																
Caries																
Abscess																
Abrasion																
Maxillary	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
Mandibular	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
Abrasion																
Abscess																
Caries																
DEH severity																
DEH type																
Parodontitis																
Calculus																

Caries (Lukacs, 1989)
Severity
1 = pit, small fissure
2 = medium-large
3 = large
4 = only root remaining

Position
O = occlusal
L = lingual
M = medial
B = buccal
D = distal
I = interprox.
M = multiple

Abscess
1 = buccal/ labial
2 = lingual
3 = internal
4 = maxillary sinus
5 = nasal cavitiy

Calculus and Periodontal Disease
(Brothwell, 1981)
1 = slight
2 = medium
3 = considerable

DEH type
(Lukas, 1989)
1 = pit
2 = line
3 = groove

DEH severity
(Schultz, 1988, adapted Jankauskaus et al, 2005)
1 = slight
2 = moderate
3 = severe

Comments:

Amara West	Cemetery:	Grave:	Individual:	Date:

Pathological changes in the skull

Orbitae

	right	left
absent/present		
Cribra orbitalia (Stuart-Macadam 1989)		
Bone formation Location		
Type (lamellar/woven)		
Comment		

Sinus maxillaris

	right	left
a/p		
changes		
Type		
dental pathologies		
Comments		

Cranial vault

Porotic hyperostosis: (Stuart-Macadam, 1989)
Ectocranial:
Endocranial:
Facial bones:
Skull base:
Mandible:
Comments:

Amara West	Cemetery:	Grave:	Individual:	Date:

Pathological changes in the postcranial skeleton

Bone formation

Element	Location	Bone Type	Activity	Distribution	Extent	Comments

Bone Type
1 = woven
2 = lamellar
3 = mixed

Activity
1 = forming
2 = healing
3 = healed

Distribution
1 = discrete
2 = multifocal
3 = diffuse

Bone destruction

Element	Location	Activity	Distribution	Extent	Comments

Amara West	Cemetery:	Grave:	Individual:	Date:

Trauma

Element	Type	Activity	Description

Radiography:

Other Pathological changes/additional observations

Amara West	Cemetery:	Grave:	Individual:	Date:

Joint Disease in the Spine

Changes
OP osteophytes
PO porosity
SN Schmorls nodes
EB eburnation
F fusion
IVD intervertebral disc disease
LV ligamenta flava

Body
1 superior body
2 inferior body

Left
3 superior facet
4 inferior facet
5 transverse process
6 costal facet

Right
7 superior facet
8 inferior facet
9 transverse process
10 costal facet

Vert.	1	2	3	4	5	6	7	8	9	10
A-Occ										
Dens										
C1										
C2										
C3										
C4										
C5										
C6										
C7										
T1										
T2										
T3										
T4										
T5										
T6										
T7										
T8										
T9										
T10										
T11										
T12										
L1										
L2										
L3										
L4										
L5										
S1										

Transition vertebrae: Yes/No Comments

Spina bifida: Yes/No Comments

Spondyloslysis: Yes/No Comments

Amara West	Cemetery:	Grave:	Individual:	Date:

Osteoarthritis of Joints

		R						L					
		p/a	OP	PO	EB	F	JC	p/a	OP	PO	EB	F	JC
TMJ	Temporal												
	M. condyle												
ACJ	Clavicle												
	Scapula												
	Sternoclavicular												
Shoulder	Glenoid												
	Humerus												
Elbow	Humerus: capitulum												
	Humerus: trochlea												
	Ulna: trochlear notch												
	Ulna: radial notch												
	Radius: articular fovea												
	Radius: circumfer. art.												
Wrist	Radius: radioulnar												
	Radius: scaphoid												
	Radius: lunate												
	Ulna: radioulnar												
Hand	Carpal												
	Carpometacarpal												
	Metacarp.-Phalang.												
	Prox. Interphalang.												
	Dist. Interphalang												
Hip	Acetabulum												
	Femoral head												
Knee	Patellofemoral												
	medial												
	lateral												
Ankle	Tibia: talocrural												
	Fibula: talofibular												
	Talus												
Foot	Tarsus												
	Tarsometatarsal												
	Metatars-Phalang.												
	Prox. Interphalang.												
	Dist. Interphalang												
Sacro-iliac joint	Illium												
	Sacrum												
Comment													

Amara West	Cemetery:	Grave:	Individual:	Date:

Additional Joint Disease

		R	L
TMJ	Temporal		
	M. condyle		
ACJ	Clavicle		
	Scapula		
	Sternoclavicular		
Shoulder	Glenoid		
	Humerus		
Elbow	Humerus: capitulum		
	Humerus: trochlea		
	Ulna: trochlear notch		
	Ulna: radial notch		
	Radius: articular fovea		
	Radius: circumfer. art.		
Wrist	Radius: radioulnar		
	Radius: scaphoid		
	Radius: lunate		
	Ulna: radioulnar		
Hand	Carpal		
	Carpometacarpal		
	Metacarp.-Phalang.		
	Prox. Interphalang.		
	Dist. Interphalang		
Hip	Acetabulum		
	Femoral head		
Knee	Patellofemoral		
	medial		
	lateral		
Ankle	Tibia: talocrural		
	Fibula: talofibular		
	Talus		
Foot	Tarsus		
	Tarsometatars.-Phalang.		
	Prox. Interphalang.		
	Dist. Interphalang		
Sacro-iliac joint	Illium		
	Sacrum		
Comment			

Amara West	Cemetery:	Grave:	Individual:	Date:

Juvenile Age Estimation

Estimated Age:

Epiphysial Fusion (Van Beek, 1983, Scheuer and Black, 2000, Ubelaker, 1989)

Epiphysis	Fused	Partially fused	Unfused		Epiphysis	Fused	Partially fused	Unfused
Metopic suture					Distal humerus			
Mental symphysis					Humerus epicondyle			
Lateral to basilar					Prox radius			
Lateral to squamous					Distal radius			
Basilar suture					Prox ulna			
C halves of arch					Distal ulna			
C arch-vert. body					Ilium to pubis			
C vert. sup. rim					Ischium to pubis			
C vert. inf. rim					Ischium to ilium			
T halves of arch					Ischial tub			
T arch-vert. body					Iliac crest			
T vert sup. rim					Prox femur			
T vert. inf. rim					Greater trochanter			
L halves of arch					Lesser trochanter			
L arch-vert. body					Distal femur==			
L vert sup. rim					Prox tibia			
L vert. inf. rim					Distal tibia			
Scapula coracoid					Prox fibula			
Scapula glen.cavity					Distal fibula			
Scapula acromion					S1-S2			
Scapula inf. angle					S2-S3			
Scapula med. border					S3-S4			
Prox humerus					S4-S5			
Estimated Age/ Comments								

Dental development (Ubelaker 1978)

Estimated Age:

Postcranial measurements (Fazekas & Kosa 1978 (fetal), Scheuer and Black 2000, Stloukal & Hanáková 1978, Ubelaker 1989):

Scapula length		Femur length	
Humerus length		Tibia length	
Clavicle length		Fibula length	
Radius length		Ilium width	
Ulna length			
Estimated Age/ Comments			

Amara West	Cemetery:	Grave:	Individual:	Date:

Dental Recording Form - Decidious Teeth

E	D	C	B	A	A	B	C	D	E
E	D	C	B	A	A	B	C	D	E

/= lost PM
X = lost AM
B = broken PM
R = root only
-- = jaw not present
A = congenital absent
NE = not erupted

Pathology and Dental Wear

	Right					Left				
Calculus										
Parodontitis										
DEH type										
DEH severity										
Caries										
Abscess										
Abrasion										
Maxillary	**E**	**D**	**C**	**B**	**A**	**A**	**B**	**C**	**D**	**E**
Mandibular	**E**	**D**	**C**	**B**	**A**	**A**	**B**	**C**	**D**	**E**
Abrasion										
Abscess										
Caries										
DEH severity										
DEH type										
Parodontitis										
Calculus										

Caries (Lukacs, 1989)
Severity
1 = pit, small fissure
2 = medium-large
3 = large
4 = only root remaining

Position
O = occlusal
L = lingual
M = medial
B = buccal
D = distal
I = interprox.
M = multiple

Abscess
1 = buccal/ labial
2 = lingual
3 = internal
4 = maxillary sinus
5 = nasal cavitiy

Calculus and Periodontal Disease
(Brothwell, 1981)
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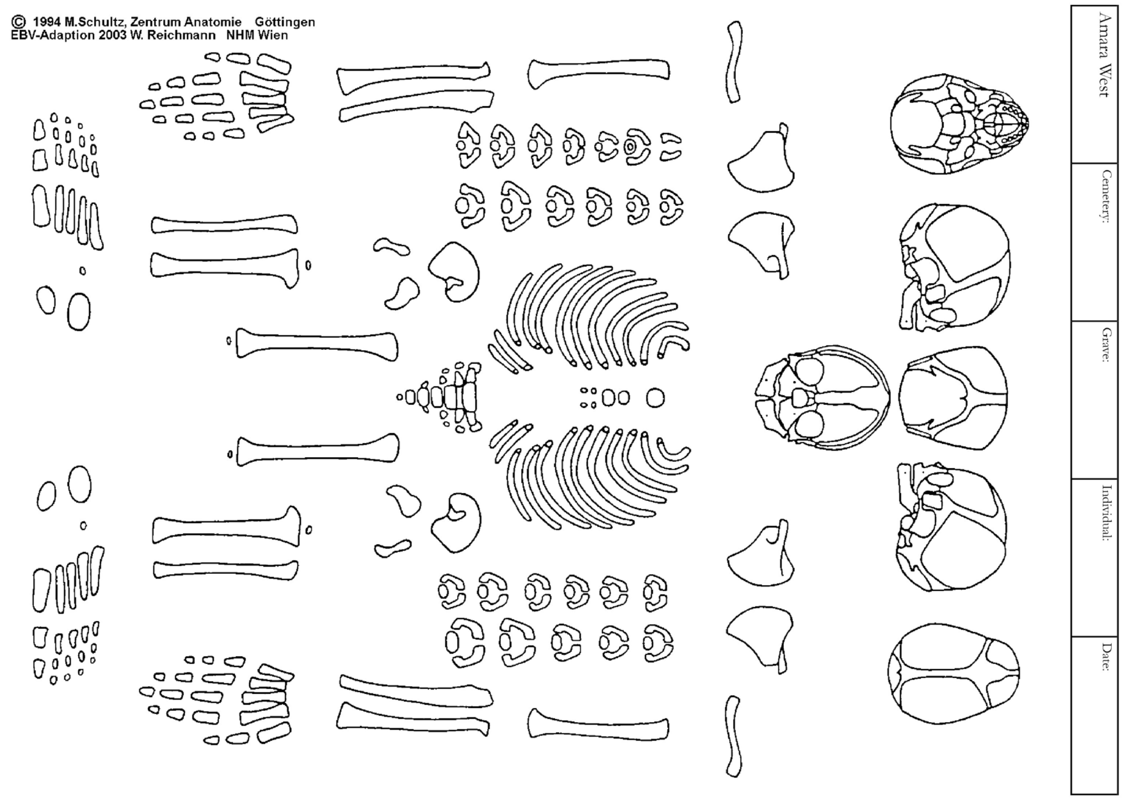
3= considerable

DEH type
(Lukas, 1989)
1 = pit
2 = line
3 = groove

DEH severity
(Schultz, 1988, adapted Jankauskaus et al, 2005)
1 = slight
2 = moderate
3 = severe

Comments/ Abnormalities: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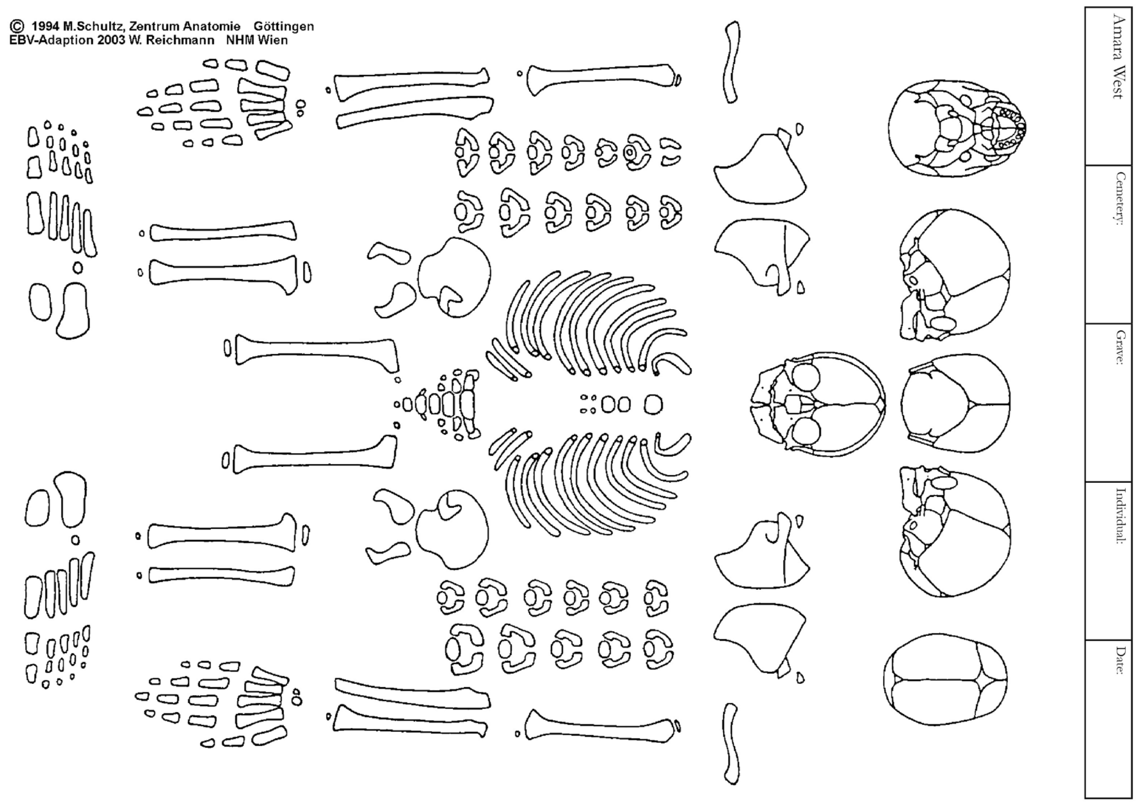
Amara West
Cemetery:
Grave:
Individual:
Date: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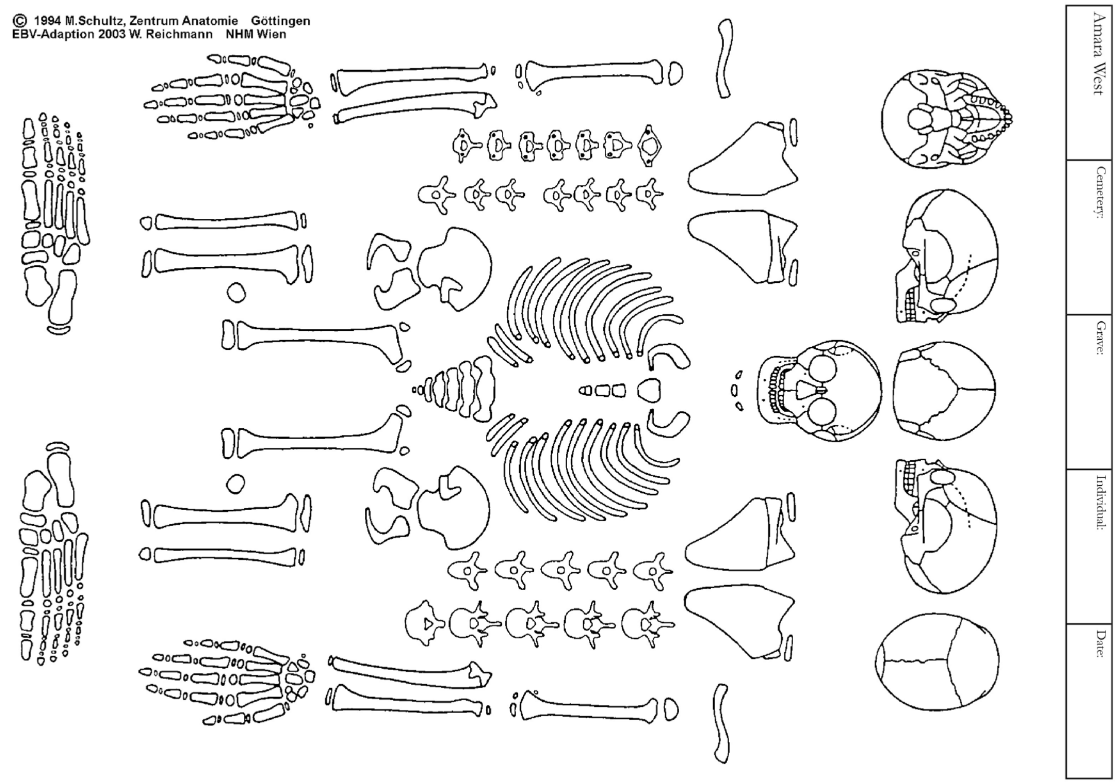
Date: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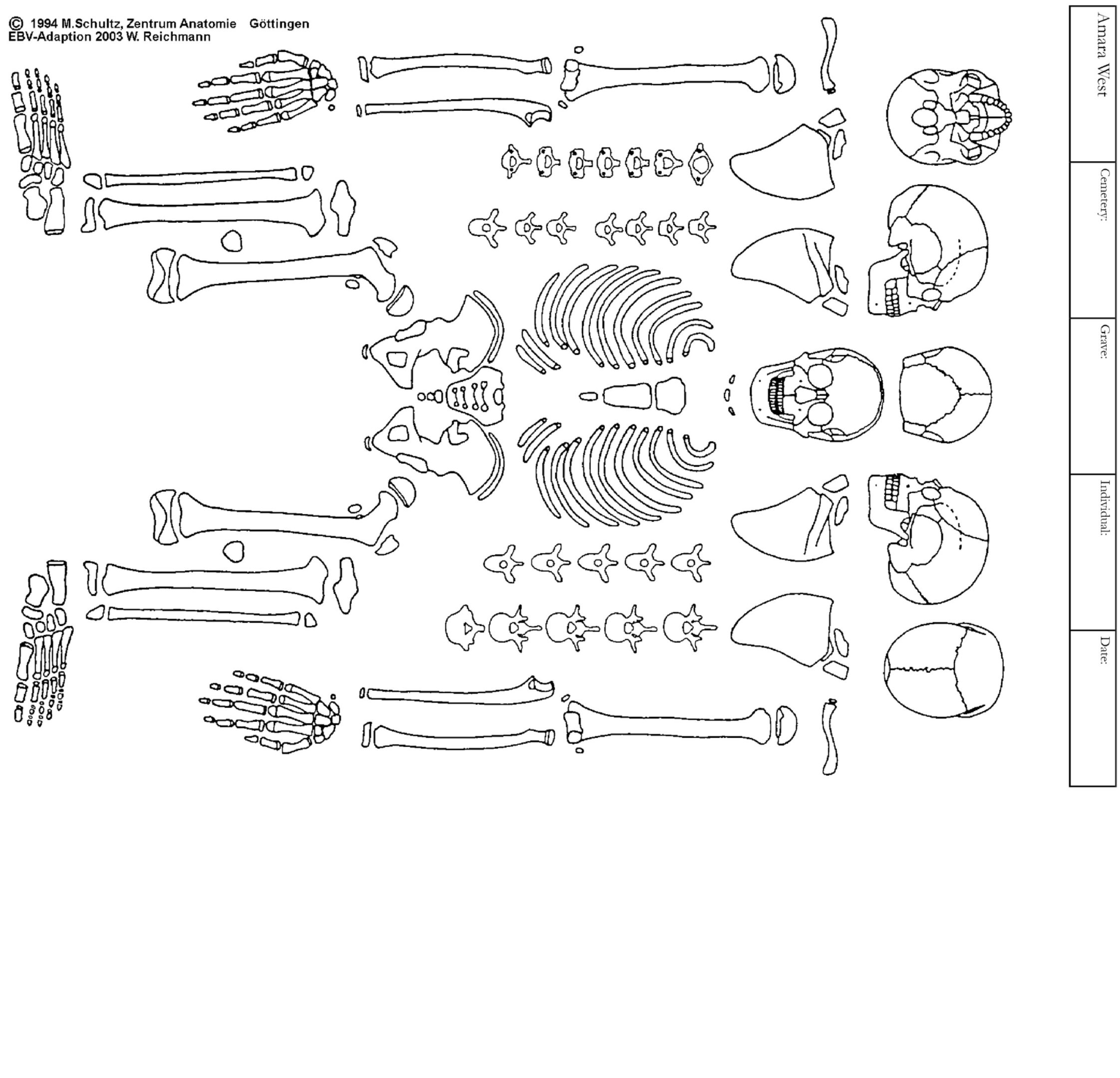
Date: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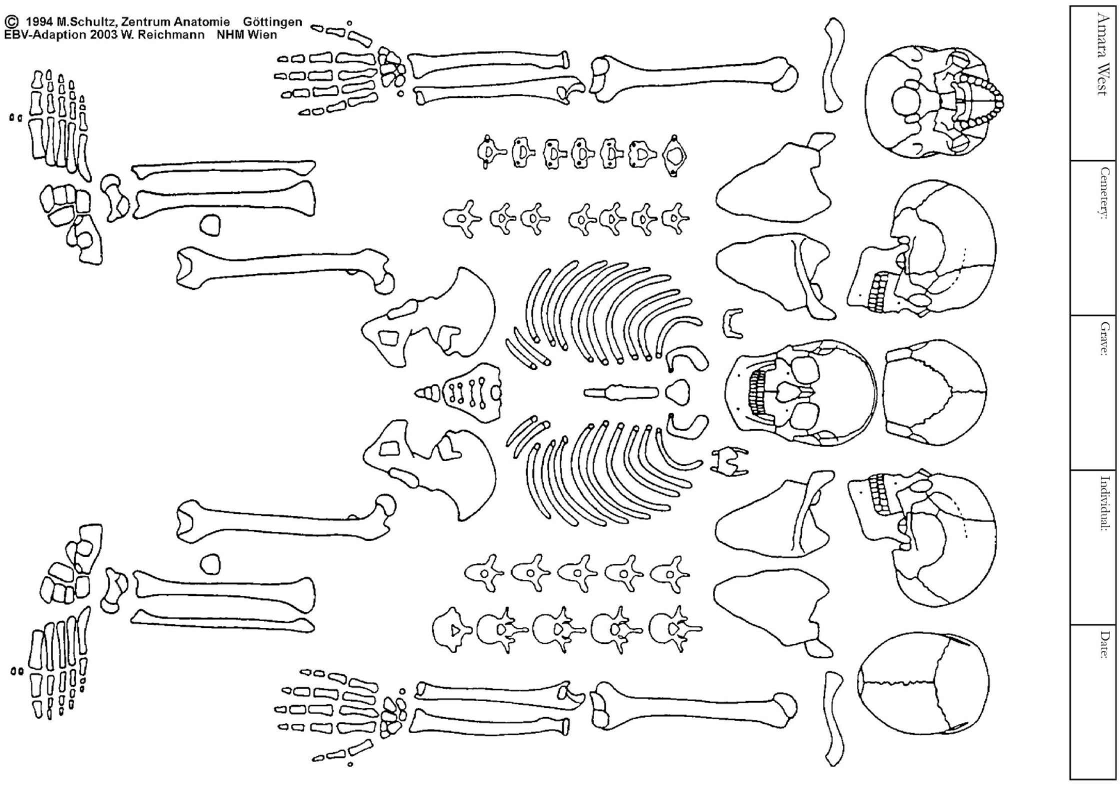
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EBV-Adaption 2003 W. Reichmann NHM Wien
Amara West
Cemetery:
Grave:
Individual:
Date:

Key to the catalogue and abbreviations used in the text

Graves

C	ceramics number
F	finds number
[8000]	brackets indicate context number
d	diameter
l	length
t	thickness
w	width

Finds and ceramics are presented in tabular form according to following template:

[Context number]	Finds-/Ceramics number	Object description

If clearly associated with a burial, finds are presented with the description of the individual.

Samples:
AS Archaeological sample
BS Botanical sample
SS Skeletal sample

Skeleton

Preservation: see Tables 8.1 and 8.2
Completeness: % of skeletal elements present

Dental status

<u>Dental status legend</u>

- - jaw not present
- / lost post-mortem
- x lost ante-mortem
- _ isolated tooth
- nE not erupted

<u>Full deciduous dentition presented as</u>:

R	m2	m1	c	i2	i1	i1	i2	c	m1	m2	L
	m2	m1	c	i2	i1	i1	i2	c	m1	m2	

<u>Full permanent dentition presented as</u>:

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Cemetery C

New Kingdom chamber tombs

G234

Orientation: E–W, burial chambers E and W (see Figure III.13)

Superstructure: -
Shaft:

Dimensions: 1.60m EW x 0.84m NS, depth: 1.74m
Description:

The shaft of the grave [9096] is rectangular and vertically carved into the alluvial silt. It was backfilled by a largely homogenous deposit of loose yellow windblown sand [9097]. Sherds and one complete beer jar were recovered from within the fill of the shaft. Narrow entrances to burial chambers are situated on the bottom of the shaft on the eastern and western side. Both doorways were originally blocked but broken open. Of the eastern door blocking [9205] only a single schist stone (33x18x4cm) as well as traces of mud plaster remain.

Ceramics

[9097]	C9019	beer jar
	C9147	plate with red-painted rim
	C9148	plate (fragmentary)

Eastern chamber:

Dimensions: 1.35m EW x 1.80m NS, height: 0.80m
Number of burials: 12
Description:

The chamber was originally not backfilled. From 0.5m below present ceiling level, the content of the chamber was covered by a dense deposit of silt rubble [9096] originating from ceiling collapse. Underneath the collapse, the chamber content was entirely covered with a deposit of yellow windblown sand [9204], which would have entered the chamber through the shaft and open doorway. Mixed within the sandy deposit were a large number of wooden fragments from funerary containers or other grave goods, sherds, plaster and disarticulated human remains. Several intact vessels were found in the western half of the chamber against the northern and southern wall (see Figure III.24). 12 adult individuals were buried within the chamber even though only eight could be recovered fully or partially articulated. All burials were made in extended position, some prone, some supine. Seven largely articulated individuals were found super-imposed in the centre of the chamber and it remains unclear whether this was their original position or whether it resulted from post-depositional disturbance. Recovery of partially articulated pairs of legs and torsos suggests disturbance occuring not long after burial.

Only a small number of grave goods (see Figure III.23) were recovered associated with individuals but also within the chamber in general, comprising three scarabs (F9164, F9167, F9169), a pair of carnelian ear-rings (F9161, F9163) and two bracelets (F9166, F9172). Badly deteriorated funerary containers comprising a dark, solid kind of wood were recovered with four individuals. Due to their poor state of preservation, identification was not possible but presumably all of them represented coffins. A large number of further wooden fragments were recovered from the back of the chamber even though none of them showed any features allowing for attributing them to an object.

Ceramics

[9130]	C9041	beer jar
	C9043	plate with red-painted rim
[9204]	C9021	beer jar
	C9038, C9039, C9040, C9154, C9155	plate with red-painted rim

Finds

[9130]	F9165	lid made from mud (8.1x4.4x7.3cm)
	F9337	fragment of a bivalve shell (2.6x1.7x0.1cm)
	F9342	larger fragments of wood from funerary container from the SE corner of the chamber (max. 16.5x10.2x3.0cm)
	F9343	fragments of white plaster, some with impression of wood on the surface (max. 8.9x6.4x3.6cm)
[9204]	F9168	lid
	F9336	small wooden fragments from funerary containers (largest fragment 6.1x3.1x1.5cm)
	F9338	large fragments of wood from funerary container from the SE corner of the chamber (max. 15.5x4.3x2.8cm)
	F9339	large fragments of wood from funerary container (max. 10.3x5.8x2.2cm)
	F9340	fragments of white plaster, some with traces of black pigment, some with wooden impressions (max. 17.2x3.4x3.2cm)

Burials

Sk234-6/ [9218]

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: partially articulated

Bone preservation: 2/4

Completeness: 11%
Sex: female
Age: adult
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	visceral on at least one rib of the right and one ribs of the left side (healed)
Endocranial changes	n/a
OA	cervical, thoracic and lumbar spine
IVD	-
Trauma	small depression fracture, healed
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

Sk234-7/ [9219]

Funerary ritual
Body Orientation: E–W
Body Position: extended, supine
Associated finds:

F9161, F9163	carnelian hair-rings with serrated edges (d: 1.9cm, t: 0.7m)

Skeleton
Articulation: partially articulated
Bone preservation: 3/4
Completeness: 43%
Sex: female
Age: adult indet.
Stature: 159.3 ± 1.0cm
Pathologies:

Orbital lesions	left vessel impressions, right n/a
NBF	right scapula, right distal tibia (healed)
Sinusitis	right healed, left n/a
Ribs	three right ribs visceral (healing)
Endocranial changes	NBF in parietal around meningeal vessels

OA	thoracic and lumbar spine elbow left, wrist and hand right
IVD	lumbar spine
Trauma	small depression fracture, healed
Dental pathologies	caries
Other pathologies	-

Dental Status

R <u>M3</u>	-	-	-	-	-	/	/	/	/	/	/	/	x	<u>M2</u>	/	L
-	-	-	-	/	/	/	-	-	-	-	-	-	-	-	-	

<u>Sk234-8/ [9133]</u>

Funerary ritual

Body Orientation: NE–SW

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 2/2

Completeness: 44%

Sex: female

Age: >36 years

Stature: -

Pathologies:

Orbital lesions	porosities right, left n/a
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	healed, very strong changes in sinus frontalis
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine
IVD	-
Trauma	-
Dental pathologies	abscesses urP3, uI2, llP4, llM1
Other pathologies	-

Dental Status

R -	-	-	-	/	x	/	-	-	-	-	-	x	-	-	-	L
-	-	x	/	-	-	/	/	/	/	/	/	/	/	x	x	

Sk234-10/ [9135]

Funerary ritual

Body Orientation: SW–NE

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 3/3

Completeness: 81%

Sex: male?

Age: 36–50 years

Biomolecular: C/O-sample AW18

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	healed, mastoiditis
Ribs	visceral side 12^{th} rib right, three ribs left
Endocranial changes	-
OA	both wrists, right hip cervical, thoracic and lumbar spine
IVD	-
Trauma	fractures Th5 and medial ulna left (healed)
Dental pathologies	abscess urC
Other pathologies	-

Dental Status:

R M3	M2	/	P4	/	/	-	-	-	-	-	-	-	-	-	-	L
M3	M2	x	/	/	/	/	-	-	-	-	-	-	-	-	-	

Sk234-12/ [9136]

Funerary ritual

Body Orientation: S–N

Body Position: extended, prone

Associated finds:

F9164 scarab in steatite with green glaze, base depicts name of Thutmosis III is in a cartouche, and is surrounded by a feather, an erected cobra and a solar disc on each side

F9166 48 small circular beads in yellow, brown, green and blue faience (d: 0.8, t: 0.3cm)

Skeleton

Articulation: partially articulated

Bone preservation: 2/4

Completeness: 47%

Sex: male

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	cervical, thoracic and lumbar spine
IVD	cervical and lumbar spine
Trauma	small depression fracture, healed
Dental pathologies	caries slight calculus
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	-	/	x	-	-	-	-	-	L
	-	M2	M1	-	-	x	x	x	I1	x	x	-	-	M1	M2	-	

Sk234-13/[9137]

Funerary ritual

Body Orientation: NE–SW

Body Position: extended, supine

Associated finds:

F9169 scarab in steatite with green glaze, base shows anthropomorphic Amun with his double feather crown stands in the middle of the falcon headed gods

Skeleton

Articulation: articulated

Bone preservation: 4/3

Completeness: 86%

Sex: female

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	five ribs left visceral (active)
Endocranial changes	-
OA	cervical, thoracic and lumbar spine ACJ left, both feet
IVD	-
Trauma	-
Dental pathologies	slight calculus
Other pathologies	-

Dental Status

R	-	M2	-	-	-	-	-	-	-	I2	-	-	-	-	x	-	L
	M3	M2	-	-	-	/	I2	I1	I1	-	-	-	-	-	-	-	

Sk234-14, [9138]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F9170	wooden coffin, fragmentary
F9171	fragments of white plaster, presumably from coffin
F9172	bracelet from 40 circular and tubular green beads in faience

Skeleton

Articulation: articulated

Bone preservation: 2/4

Completeness: 31%

Sex: female

Age: 20–30 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a
OA	lumbar spine

	hand left
IVD	n/a
Trauma	fracture left distal ulna (healed)
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk234-15/ [9224]

Funerary ritual

Body Orientation: E–W
Body Position: extended, supine
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: 2/3
Completeness: 24%
Sex: female
Age: >50 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	n/a
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk234-16/ [9139]

Funerary ritual

Body Orientation: N–S
Body Position: extended, supine
Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 3/4

Completeness: 60.2%

Sex: indifferent

Age: adult indet.

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	scapular blade ventral left and right (healed) new bone formation on the both tibiae and both fibulae (healed)
Sinusitis	right (healed)
Ribs	right four lower including 12th (healed)
Endocranial changes	hypertrophy along sulcus sinus sagittalis, enlarged mastoid cells with spiculae which possibly represent new bone formation
OA	thoracic and lumbar spine elbows, hands, wrists, ankles
IVD	thoracic and lumbar spine
Trauma	small depression fracture, healed
Dental pathologies	DEH
Other pathologies	RCD

Dental Status

R M3	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	L
M3	x	x	-	-	<u>C</u>	-	-	-	-	-	-	-	-	-	-	

<u>Sk234-17/ [9203]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 49%

Sex: male

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	healed, also in sphenoid sinus
Ribs	-
Endocranial changes	increased impressions along A. meningea media on both sides
OA	n/a
IVD	n/a
Trauma	-
Dental pathologies	abscesses in maxilla, rM1-rM3, lC, lM2, lM3 moderate calculus and periodontal disease caries dental crowding
Other pathologies	-

Dental Status:

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	/	M2	M1	/	/	C	/	/	/	I2	/	P3	/	M1	M2	M3	

Eastern chamber:

Dimensions: 2.70m EW x 2.20m NS, height: 0.90–1.0m

Number of burials: 8

Description:

The chamber was not originally backfilled. A deposit of loose yellow windblown sand [9202] covered the eastern half of the chamber and would have entered through the destroyed door blocking. Mixed within the sand was a large amount of small, unassociated wooden fragments. The articulated, flexed burial Sk234-1 was recovered from the entrance area, partially resting within the entrance. A substantial amount of windblown sand was found underneath the burial, potentially indicating the burial was made at a time when some sand had already entered the chamber. Four more articulated, extended burials were recovered in the western half of the chamber, partially superimposed and resting on the cut floor of the chamber, suggesting one continuous phase of usage. Further three individuals were recovered entirely disarticulated in the back of the chamber. While a sub-adult individual (Sk234-9) could partially reassembled, two more middle adult males were very similar and impossible to disentangle.

Ceramics

[9202] C9020 beer jar

Finds

[9202] F9157 large amount of wooden fragments (max. 5.4x2.2x0.8cm)

Burials

Sk234-1/ [9212]

Funerary ritual

Body Orientation: W–E

Body Position: flexed

Associated finds:

F9156 doum palm wrapping, BS118

Skeleton

Articulation: articulated

Bone preservation: 2/4

Completeness: 75%

Sex: female?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions bilateral
NBF	-
Sinusitis	healed
Ribs	visceral side of at least three right and five left (healed)
Endocranial changes	*Hyperostosis frontalis interna*
OA	cervical, thoracic and lumbar spine
IVD	lumbar spine
Trauma	healed depression fracture (d: 0.7cm) on frontal bone above orbit
Dental pathologies	abscess on ul1, llI2, llC, llP3 woven bone deposition in right *foramen mandibulae*
Other pathologies	-

Dental Status:

R	-	-	-	x	x	x	/	/	/	x	x	x	x	x	x	x	L
	M3	-	-	-	P3	C	x	x	x	x	/	x	x	x	-	-	

Sk234-2/ [9213]

Funerary ritual

Body Orientation: SW–NE

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: partially articulated

Bone preservation: 3/4

Completeness: 40%

Sex: female

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	visceral side of four right ribs (healed
Endocranial changes	slight hyperostosis frontalis interna NBF along branches of A. meningea media, nodular NBF in frontal granular impressions in occipital
OA	cervical, thoracic and lumbar spine
IVD	-
Trauma	healed fracture to the right acromion fracture vertebral body L1 fracture to proximal phalanx right
Dental pathologies	abscess lrM3
Other pathologies	possible evidence for osteoporosis (Figure III.111)

Dental Status

R M3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
M3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Sk234-3

Funerary ritual

Body Orientation: S-N

Body Position: extended, supine

Associated finds:

F9158 doum palm coffin

F9160 fragment of bead from calcite (d: 0.7cm)

Skeleton

Articulation: articulated

Bone preservation: 3/3

Completeness: 41%

Sex: female
Age: adult indet.
Stature: -
Pathologies:

Orbital lesions	slight NBF roof right orbit, left n/a
NBF	left scapular blade (*fossa supraspinalis*), mixed changes possibly connected to RCD
Sinusitis	healed
Ribs	right four lower and 12th rib visceral side (healed)
Endocranial changes	slight hyperostosis frontalis interna deep enlarged vessel impressions in *sulcus sinus sagittalis*
OA	right TMJ, right hand, RCD cervical, thoracic and lumbar spine
IVD	cervical spine
Trauma	one right lower rib (healed)
Dental pathologies	abscess on rlM1, caries
Other pathologies	advanced osteoporosis (see Figure III.111)

Dental Status

R	-	-	-	-	x	x	x	x	x	x	x	x	-	-	-	-	L
	-	x	M1	-	P3	C	-	-	-	-	-	-	-	-	-	-	

Sk234-4/ [9217]

Funerary ritual

Body Orientation: NW–SE
Body Position: extended, supine
Associated finds:

F9159 doum palm coffin
F9162 wood, perhaps coffin but unclear association

Skeleton

Articulation: articulated
Bone preservation: 4/3
Completeness: 63%
Sex: female
Age: >36 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions
NBF	right scapular blade

	right tibia and fibula entire shaft (healed)
Sinusitis	extensive changes (mixed)
Ribs	-
Endocranial changes	plaque-like NBF in frontal deep impressions in the parietal bones of both *A. meningea media* hypertrophy along *Sulcus sinus sagittalis,* NBF and small vessel and granular impressions
OA	thoracic spine ACJ right
IVD	-
Trauma	small depression fracture, healed
Dental pathologies	periapical lesions urP3, urC, urI2, ulI2, ulC, ulP3, ulP4, ulM1 large abscess (d: 1.3cm) in mandible, active NBF in abscess cavities, new bone formation on maxilla surrounding the lesion, NBF (woven) around uM2 labial and uM3 slight to moderate calculus, moderate periodontitis caries
Other pathologies	-

Dental Status

R	x	M2	M1	P4	x	C	I2	I1	I1	I2	C	P3	P4	M1	x	M3	L
	x	x	x	P4	P3	C	I2	I1	x	I2	C	P3	P4	x	x	x	

<u>Sk234-5/ [9216]</u>

Funerary ritual

Body Orientation: S–N
Body Position: extended, supine
Associated finds:

F9341 coffin or wrapping, fragmentary

Skeleton

Articulation: partially articulated
Bone preservation: 4/3
Completeness: 57%
Soft tissue: brain SS40
Sex: male
Age: 36–50 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions in orbital roof left, right n/a
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	healed changes in frontal sinus

Ribs	visceral on at least four right and four left ribs (healed)
Endocranial changes	-
OA	cervical and thoracic spine
IVD	lumbar spine
Trauma	-
Dental pathologies	abscess llM1 caries moderate calculus and periodontal disease
Other pathologies	-

Dental Status

R	M3	M2	-	-	x	x	x	x	I1	/	x	x	x	x	x	x	L
	-	M2	-	-	-	-	-	x	x	x	-	-	P4	M1	M2	M3	

Sk234-9/ [9202]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 2/2

Completeness: 45%

Sex: indifferent

Age: 10–12 years

Stature: -

Pathologies:

Orbital lesions	porosities
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	strong vessel impressions, particularly A. meningea media, along vessel impressions and sinuses small patches of new bone formation
OA	-
IVD	-
Trauma	-
Dental pathologies	caries
Other pathologies	-

Dental Status

R		M1	P4	/	C	I2	/	/	/	C	P3	P4	M1		L
	M2	M1	/	/	C	/	/	/	/	/	P3	P4	M1	M2	

G244

Orientation: E–W, burial chambers E (two) and W (three)

Superstructure:

Dimensions: 18.0m EW x 16.0m NS

Description:

On the surface, the tomb is marked by a low tumulus consisting of alluvial silt. The mound is covered by a loose scatter of schist stones. Additionally, a large amount of Napatan sherds as well as disarticulated and heavily eroded human skeletal remains were found scattered around the mouth of the shaft.

Shaft:

Dimensions: 2.20m EW x 1.10m NS, depth: 2.80m

Description:

The shaft is rectangular, aligned on an E–W axis and vertically carved into the alluvial silt (cut [9237]). Until a depth of 1.70m below present surface level, the shaft was backfilled with a deposit of loose, yellow windblown sand [9236]. To a depth of 1.70m, a thick deposit of debris from the disturbed burial chambers [9238] filled the entire shaft and extends into the chambers on the eastern and western side with no clear demarcation. A large, horizontally placed schist stone plate, presumably represented remnants of the destroyed blocking structure to the entrance of the western suite of chambers. [9238] held a large amount of disturbed, eroded human bones, sherds, wooden fragments, plaster fragments and a few finds. Underneath [9238], another deposit of windblown sand [9205] of 0.40m thickness attests to the fact that sand had already entered the shaft before looting occurred.

Excavation had not finished by the time of writing of this thesis, therefore only Chamber 244.3 can be presented here. A detailed description of the additional chambers has to await publication.

Chamber 244.3 (western central chamber):

Dimensions: 2.65m EW x 2.60m NS, height: 1.20m

Description:

The western central chamber is rectangular with a flat floor, flat ceiling and vertical walls. The entrance to the chamber was originally rectangular but was not intact anymore upon excavation. The chamber had not been backfilled and was covered by a deposit of windblown sand [9242]. Larger chunks of ceiling collapse were observed on top of the deposit on the western side of the chamber. The eastern third of the fill was entirely disturbed and held disarticulated remains of several individuals together with a large amount of ceramic sherds and coffin fragments (see Figures III.25–28). The burials in the western half of the chamber had been protected by windblown sand and were largely intact. However, the fact that they were superimposed suggests they were not in their original position due to an earlier episode of looting. Of the upmost burials Sk244-1 and Sk244-2, only the lower extremities remained articulated. Three burials (Sk244-3, Sk244-4 and Sk244-6) were situated E–W orientated on the northern side of the chamber on top of each other. Sk244-5, Sk244-8 and Sk244-10 were found underneath.

Burials

Sk244-1/ [9248]

Funerary ritual

Body Orientation: -

Body Position: extended, supine

Associated finds:

F9295 wood and plaster fragments from coffin, plaster bears traces of red pigment

Skeleton

Articulation: partially articulated

Bone preservation: 4/3

Completeness: 15%

Sex: indifferent

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk244-2/ [9503]

Funerary ritual

Body Orientation: -

Body Position: extended, supine

Associated finds:

F9296 wood and plaster fragments from coffin, no traces of paint (largest fragment l: 7.1cm, w: 2.0, t: 1.0)

F9299 plaster fragments with impressions of textile (largest fragment l: 8.7cm, w: 4.9cm, t: 2.2)

Skeleton

Articulation: partially articulated

Bone preservation: 4/3

Completeness: 15%

Sex: indifferent

Age: 21–30 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk244-3/ [9511]

Funerary ritual

Body Orientation: W–E (unclear if original position)

Body Position: extended, supine

Associated finds:

F9706 fragment of coffin with remains of wood and white plaster, l: 20.0cm, w: 11.0cm, t: 3.5cm

F9734 coffin fragments of wood and plaster (black, yellow and red paint, largest fragment l: 4.5cm, w: 4.0cm, t: 4.0cm)

F9735 small fragment of red, yellow and black painted plaster from coffin (l: 7.8cm, w: 6.2cm, t: 0.3cm)

F9736 fragment of coffin with yellow, red and black decoration (l: 19.8cm, w: 13.5cm, t: 1.0cm)

F9738 scarab, steatite with remains of green glaze, depicting a royal name inside a cartouche (*Aa-kheperou-ra*), name of Amen-Ra on one side and a winged sun (?) on the other, l: 1.6cm, w: 1.2cm, t: 1.1cm

F9741 small (largest fragment: l: 5.5cm, w: 4.0cm, t: 1.0cm) fragments of plaster with yellow and red pigment

F9748 fragments of white plaster with textile impressions (largest fragment: l: 2.0cm)

F9758 small fragment of red, yellow and black painted plaster from coffin (l: 5.5cm, w: 2.4cm, t: 1.6cm)

Skeleton

Articulation: articulated
Bone preservation: 5/2
Completeness: 62%
Sex: male?
Age: 18–22 years
Stature: 179.1 ± 1.7cm
Biomolecular: C/O-sample AW34
Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	NBF on skull base in frontal and occipital bone
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH mild calculus and periodontal diseaes
Other pathologies	-

Dental status

R	M3	/	M1	P4	P3	C	/	I1	I1	I2	C	P3	P4	M1	M2	/ L
	nE	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	/	M2	/

Sk244-4/ [9506]

Funerary ritual

Body Orientation: E–W
Body Position: extended, supine
Associated finds:

F9653 small fragments of textile (l: 2.3cm, w: 2.2cm)

Skeleton

Articulation: disarticulated
Bone preservation: 4/4
Completeness: 28%
Sex: male?
Age: 36–50 years
Stature: -
Pathologies:

Orbital lesions	porosities, NBF on floor of orbital cavity
NBF	-
Sinusitis	remodelled NBF in frontal and maxillary sinuses
Ribs	NBF visceral on at least five ribs, remodelled
Endocranial changes	-
OA	all sections of the spine both ACJ, both elbows, both hands
IVD	all sections of the spine
Trauma	vertebral body fractures on Th10 and L4 healed fractures on the sternal end of three right lower ribs
Dental pathologies	DEH calculus and periodontal disease
Other pathologies	calcified structures along cervical and thoracic spine

Dental status

R	-	-	-	-	-	C	-	-	I1	-	-	-	-	-	-	- L
	/	M2	x	x	x	/	/	x	x	/	/	/	/	x	x	x

Sk244-5

Funerary ritual

Body Orientation: N–S
Body Position: extended, supine
Associated finds:

F9653 small fragments of textile (l: 2.3cm, w: 2.2cm)
F9668 small fragments of white plaster with yellow, blue and red paint (largest fragment: l: 3.4cm, w: 2.6cm, t: 1.2xm)
F9672 very small fragments of textile
F9673 six small fragments of wood from coffin (largest fragment: l: 3.2cm, w: 2.0cm, t: 0.8cm)
F9684 scarab in ivory, depicting two seating lions looking backwards and sun disc in between (l: 1.5cm, w: 1.1cm, t: 0.8cm)
F9705 fragments of white plaster with traces of paint (largest fragment: 13.0cm, w: 8.0cm, t: 3.5cm)
F9715 two fragments of coffin with yellow and red paint (larger fragment: l: 5.6cm, w: 2.2cm, t: 2.2cm)

F9744 small yellow, red and white elements of coloured plaster (largest fragment: l: 2.8cm, w: 2.0cm, t: 1.4cm)

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 68%

Soft tissue: brain tissue SS52

Sex: female

Age: 21–35 years

Biomolecular: C/O-sample AW32

Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	remodelled changes in the maxillary sinuses
Ribs	active foci visceral on three right ribs
Endocranial changes	NBF on skull base in frontal and occipital bone
OA	cervical and thoracic spine left TMJ, right hip
IVD	-
Trauma	-
Dental pathologies	DEH mild calculus and periodontal disease
Other pathologies	NBF in mastoid process

Dental status

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	/	I1	I1	/	C	/	P4	M1	M2	M3	

Sk244-6/ [9508]

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3

Completeness: 73%

Sex: male

Age: 36–50 years

Stature: 166.4 ± 1.3cm

Pathologies:

Orbital lesions	vessel impressions and NBF in roofs and sides
NBF	mixed changes on the ventral aspect of the right scapular blade remodelled in mastoid process
Sinusitis	strong remodelled changes in both maxillary sinuses, the frontal sinus and mastoid process
Ribs	visceral remodelled changes on four right side lower ribs including 11th and at least three ribs of the left side
Endocranial changes	-
OA	all sections of the spine both TMJ, ACJ, shoulders, elbows, wrists, right hand, both hips, knees
IVD	cervical, thoracic and lumbar spine
Trauma	healed fracture of one proximal phalanx right
Dental pathologies	DEH calculus and periodontal disease caries periapical lesions on urI1, urI2, ulI1, ul2 and llM1
Other pathologies	calcified structures-(see Figures III.143, III.144)

Dental status

R	x	x	M1	x	x	/	I2	I1	I1	x	C	x	x	x	M2	M3	L
	/	/	/	/	/	C	/	/	/	I2	/	P3	P4	/	/	M3	

<u>Sk244-7/ [9514]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 26%

Sex: indifferent

Age: 20–30 years

Stature: 160.5 ± 3.1cm

Pathologies:

Orbital lesions	n/a
NBF	remodelled on the left tibia along the entire shaft
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a

OA	n/a
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk244-8/ [9515]

Funerary ritual

Body Orientation: S–N

Body Position: extended, supine

Associated finds:

F9712	coffin fragments (wood and plaster with red and yellow pigment, largest fragment: l: 8.2cm, w: 3.6cm, t: 2.2cm)
F9712	wooden fragments from coffin (largest fragment l: 5.3cm, w: 3.0cm, t: 2.1cm)
F9722	textile fragments (l: 4.5cm, w: 4.0cm, t: 1.0cm)
F9723	cowroid amulet with green glaze, depicting Bes figure: l: 2.3cm, w: 1.3cm, t: 0.7cm
F9743	fragments of wood and plaster from coffin (largest fragment: l: 14.9cm, w: 9.1cm, t: 5.0cm)
F9745	coffin fragments (largest fragment l: 3.7cm, w: 1.9cm, t: 1.8cm)
F9746	fragments of wood, coffin?, l: 6.0cm, w: 1.2cm, t: 1.0cm

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 67%

Soft tissue: brain tissue SS65, soft tissue underlying skull SS58

Sex: male?

Age: 25–35 years

Stature: -

Pathologies:

Orbital lesions	porosities, NBF on floor of orbital cavity
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine both elbows
IVD	cervical spine
Trauma	-

Dental pathologies	DEH moderate calculus and periodontal disease
Other pathologies	metastatic carcinoma (see Figures III.135–142)

Dental status

R	M3	M2	M1	P4	P3	/	/	I1	I1	I2	/	P3	P4	M1	M2	M3	L
	M3	M2	M1	/	/	/	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk244-9/ [9513]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 18%

Sex: female?

Age: adult

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a
OA	both elbows and wrists
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk244-10/ [9519]

Funerary ritual

Body Orientation: S–N

Body Position: extended, supine

Associated finds:

F9357	plaster pieces with red and yellow paint from coffin (largest piece: l: 13.0cm, w: 7.0cm, t: 3.2cm)
F9358	wooden fragments associated with F9357 (largest fragment l: 1.0cm, w: 0.7cm, t: 0.3cm)
F9369	scarab in ivory, carved scene with a hypo and a long-horned mammal
F9446	three wooden dowels, l: 3.3cm, w: 0.5cm, t: 0.3cm
F9740	fragments of wood and plaster from coffin (largest fragment: l: 8.6cm, w: 2.1cm, w: 0.6cm)
F9742	coffin fragment with blue and red decoration, l: 6.0cm, w: 5.0cm, t: 0.3cm
F9747	small worked ivory element in shape of a petal, l: 1.7cm, w: 0.8cm, t: 0.3cm

Skeleton

Articulation: disarticulated

Bone preservation: 5/4

Completeness: 60%

Sex: female

Age: 20–35 years

Stature: 159.0 ± 0.2cm

Pathologies:

Orbital lesions	NBF on orbital roof and floor of orbital cavity
NBF	one right middle rib with strong nodular NBF
Sinusitis	remodelled changes in both sinuses
Ribs	
Endocranial changes	HFI
OA	all sections of the spine both ACJ, left elbow
IVD	cervical spine
Trauma	healed fracture of medial right clavicle
Dental pathologies	DEH moderate calculus and periodontal disease caries AMTL
Other pathologies	small circular calcification (lymph node?), d: 8.6cm

Dental status

R	x	M2	x	x	x	x	I2	I1	I1	I2	C	P3	P4	M1	x	M3	L
	/	/	/	/	/	C	I2	I1	I1	I2	/	P3	P4	M1	M2	M3	

Post-New Kingdom chamber tombs

G200

Orientation: E–W, burial chambers E and W

Superstructure: -
Shaft:

Dimensions: 0.90m EW x 0.80m NS, depth: 0.50m
Description:
The rectangular shaft was entirely backfilled with windblown sand [9005], most of its height was lost due to wind erosion. In the western part of the passage there was a shallow, wall-like structure made of schist stones interconnected with mud [9004], presumably representing the remnants of an entrance blocking to the western chamber.

Ceramics

[9005]	C9000	pilgrim flask
	C9002, C9003, C9004, C9102, C9108	bowl with red painted rim
	C9101	red slipped jar

Eastern Chamber:

Dimensions: 1.10m EW x 2.30m NS, depth: 0.50m
Description:
Due to erosion, the burial chamber was reduced to only 50cm in height. The fill [9001] consisting of windblown sand mixed with a little bit of silt held a few, degraded pieces of wood, though considerably less the western chamber. In addition to a large number of disarticulated human remains, there were three articulated torsi piled up against the entrance as well as several partly articulated feet. The bones were generally in a very bad state of preservation and only covered by loose windblown sand, leaving it very difficult detect possible articulations. The presence of partly articulated elements suggests that there was tissue still adhering to the joints at the time of the disturbance of the grave.

Finds

[9001]	F9000	piece of white moulded plaster, hand-smoothed 'front' surface decorated with a band of red, 'below' which are alternating black and yellow strokes on white background, possibly decoration of coffin or bed (8.3x3.6x3.0cm)
	F9005	bead, red-brown carnelian, finely polished, spherical with symmetrically drilled hole Dimension: 0.2x0.3cm, hole diameter 0.1cm
	F9006	bead, red-brown carnelian, finely polished, spherical with symmetrically drilled hole

	Dimensions: 0.2x0.4cm, hole diameter 0.1cm
F9007	bead, white quartz/ rock crystal. Cylindrical with tapering sides. Badly covered in salt incrustations.
	Dimensions: 0.3x1.2cm, hole diameter 0.5cm
F9008	25 light blue faience disc beads, 117 brown-red spherical quartzite beads.
	Dimensions: Faience: d: 0.2cm, t: 0.1cm; Quartz: d: 0.3cm, t: 0.2cm

Western chamber

Dimensions: 1.10m EW x 2.40m NS, depth: 0.50m

Description:

Similar to the shaft and eastern chamber, the western chamber's height is reduced to ~0.40-0.50m in depth due to wind erosion. The remaining sidewalls are straight and vertical; the outline of the chamber is round. The chamber was backfilled with windblown sand mixed with little alluvial silt [9002]. The content of the disturbed burial chamber comprised a large amount of wooden fragments representing remnants of wooden funerary furniture such as coffins or funerary beds as well as wooden grave goods. In addition the chamber contained a considerable number of heavily eroded isolated human remains, even though the amount is smaller than in the eastern burial chamber.

G201

Superstructure: -
Shaft:

Dimensions: 0.85m NS – 1.9m EW, depth: 1.8m

Description:

The shaft [9008] is rectangular and carved vertically into the alluvial silt. The walls are straight and do not display any signs of plastering. The backfill of the shaft [9007] consists mainly of windblown sand mixed with little alluvial silt breaking away from the sides. Small amounts of disarticulated human remains, wooden fragments, sherds and plaster were recovered from the backfill.

Ceramics

[9007]	C9115, C9117	bowls with red-painted rim
	sherds of six bowls	(two red burnished) five plates, four unindentified rims

Finds

[9007]	F9009	amulet, glazed composition in the form of a stylized arrow-head (l: 2.1cm, t: 0.2cm)
	F9013	hand-modelled ceramic disc (t: 0.5cm, d: 6.3cm)
	F9033	white plaster (wall painting?, l: 13.0cm, w: 3.1cm, t: 3.4cm)

Eastern chamber:

Dimensions: d: 2.8m, height: 0.9m
Number of burials: MNI 37
Entrance: The entrance was originally blocked by a structure [9020] consisting of a shallow wall on the bottom, a large sand stone plate (104x43x14cm) and mud plaster to fill in the gaps. The blocking structure had been partly destroyed by looters with the remaining elements being scattered in the shaft.
Chamber: The chamber is roughly circular and hewn into the alluvial silt (cut [9042]). The chamber was not entered for excavation due to the instability of the roof. It was backfilled with windblown sand to about a half of the chamber's original height. Underneath the sand, the chamber was filled with a dense layer of disarticulate and commingled remains of a large number of adult and sub-adult individuals together with a large amount of finds [9018] (see Figures III.41–45).

Finds

[9018]	F9018	large amounts of beads (spherical carnelian beads, a biconical faience bead, one cowry-shell, a bone triangular pendant, six bone disc beads, two red-brown quartz disc beads, and seven faience disc beads (including a group of three still adhered together) and two tubular faience beads) d: 0.3-0.9mm
	F9019	terminal from the top of a funerary bed leg, trapezoidal in plan, with a concave upper surface (l: 5.1cm, w: 6.5cm, t: 6.1cm)
	F9020	tubular wooden cosmetic container, l: 6.1cm, d: 2.8cm
	F9021, F9028,	coarse fragments of matting, l: 2.5mm
	F9022	partly curving wooden object, with two channels containing pigment (black and red, respectively), l: 9.2cm, w: 1.9cm, t: 1.2cm
	F9023	finely polished dark wood applicator, slightly bulbous at ends (l: 9.7cm, d: 0.4cm)
	F9024	scarab from steatite with pale blue-green glaze. decoration: prenomen *Men-kheper-re* on right, above *neb*-basket, column of signs to right, with *bity*-title, *mntt*, above figure of sphinx. Incised border line. Hole drilled longitudinally l: 2.2cm, h: 1.1cm, w: 1.5cm
	F9027	rectangular faience plaque, covered with a relatively fine, glassy, blue-green glaze. Decoration on both sides: Two standing male gods, facing each other, and near hands grasped together, other side with almost identical scene, though less well-carved. l: 1.6cm, w: 1.3cm, t: 0.5cm
	F9029	oyster shell (l: 8.9cm, w: 7.3cm, t: 2.6cm)
	F9037, F9038	cornelian penannular ear-rings (t: 0.5cm, d: 1.3cm)
	F9039	large scarab in faience with deep blue glaze, base is partially broken away, intact part with a sun disc and top of two ostrich feathers preserved (l: 4.7cm, w: 2.8cm, t: 1.7cm

F9040	one half of bivalve shell (w: 3.7cm, t: 1.3cm)
F9041	small faience amulet with blue glaze. Isis figure in standing position (h: 1.8cm, w: 0.4cm, t: 0.4cm)
F9042	group of beads: four cornflower beads with black glaze (l: 1.1cm, w: 0.5cm, t: 0.2cm) together with one hemispheric bone or ivory bead (d: 1.1cm, t: 0.3cm)
F9043	wooden terminal from funerary bed leg, trapezoidal base and circular end of bed leg (h: 12.5cm, w: 7.0cm, t: 6.5cm)
F9044	thin-walled bowl from copper alloy (d: 21.0cm, t: 0.2cm)
F9045	copper alloy object, purpose unknown (l: 1.6cm, w: 2.6cm, 0.1cm)
F9046	trapezoidal base of bed leg terminal with incised decorations (h: 5.4cm, w: 4.1cm, t: 2.4cm)
F9047	five beads and pendants: two black-glazed faience cornflower beads with flat back (l: 1.4cm, t: 0.7cm, w: 0.3cm), one three-dimensional cornelian cornflower bead (l: 1.1cm, t: 0.6cm) and two spherical cornelian beads(d: 0.6cm , t: 0.5, d: 1.0cm t: 0.9cm)
F9055	scarab from steatite: upper register: recumbent animal with double rush crown embellished with a pair of *uraei,* outstretched falcon wings, a further sign is carved in front of the animal, lower register: winged scarab (l: 1.8cm, w: 1.3cm, t: 0.8cm)
F9056	penannular ear-ring, cornelian (t: 0.5cm, d: 1.6cm)
F9058	Bes amulet, faience with deep blue glaze (l: 3.4cm, w: 1.4cm, t: 0.6cm)
F9059	quartzite rubber or smoother (d: 8.2cm, h: 6.1cm)
F9064	head-rest, top part, wood (h: 7.2cm, w: 15.cm, fitting hole 1.0x2.3cm)
F9066	oyster shell (l: 8.3cm, w: 5.3cm, t: 2.5cm)
F9067	spherical and cylindrical beads in blue quartz, red quartz and blue-glazed faience, d: 0.4cm
F9075, F9076	funerary bed leg fittings in form of a raised ellipsoid with rectangular hole for attachment (t: 2.2cm; 7.1x5.5cm; t:1.6cm; 8.1x5.2cm)
F9077, F9080	trapezoidal bases from a wooden bed leg terminal, with four parallel lines carved as a decorative motif (h: 4.8cm, w: 8.5cm, t: 6.6cm)
F9078	circular terminal from funerary bed with four parallel bands incised around main part (h: 7.3cm, d: 7.3cmm)
F9079	fragments of white plaster, partially painted (red, black) , largest fragment (no painted surface): 20.3x6.1x3.1cm, largest fragment (painted surface): 11.6x6.2x0.6cm
F9088	large group of beads: a mass of small faience disc beads (blue glaze, d: 0.3mm, t: 0.1mm), two cylindrical cornelian beads (d: 0.4mm, t: 0.4mm), two spherical cornelian beads (d: 0.3mm), four ovoid faience beads (blue glaze, d: 0.4mm, l: 0.5mm), five blue quartz ovoid beads d: 0.4mm, l: 0.5mm and one black glazed faience flat cornflower pendant (l: 1.2mm).
F9093	thin piece of white painted plaster with depiction of falcon-headed god with long beak (h: 6.5cm, w: 11.7cm, t:

		0.6cm)
	F9109	base of a wooden headrest, incised decor near the edge, and four parallel lines closer to the centre (l: 16.9cm, h: 4.6cm, t: 6.0cm) fitting for shaft 3.2x2.8cm
	F9660	head-rest, part of fitting from base (l: 5.2cm, w: 1.7cm, t: 1.4cm)
	F9666	Head-rest, top part, wood (l: 7.1cm, t: 1.9cm)
	F9032, F9035, F9037 F9043, F9046, F9057 F9075, F9106, F9110–9117, F9124, F9125, F9129-F9131	Large number of wooden fragments of funerary beds or coffins

Ceramics

[9018]	C9013, C9016, C9112, C9117, C9119, C9120, C9123, C9130, C9134	bowls with red painted rims
	C9121, C9122, C9125 C9126, C9124, C9135	plates
	C9015	small marl clay jar
	C9014,	large jar with small handles
	C9128, C9129	large jars without handles
	C9131	pilgrim flask
	+ 8 bowls, 7 plates, 1 base of bowl or plate, 3 jars which 1 base in marl clay, 14 rims without numbers	

Burials

Due to excavation methods, the skeletons could only be recovered within one large commingled context [9018]. The individuals vary a lot in preservation and completeness with a large proportion of bones missing. Thus, the large number of individuals and the high degree of disturbance only allows for a rough estimation of the total number of individuals originally buried within the two chambers. The minimum number of individuals established was 27 adults and 11 sub-adults in the eastern chamber as well as nine adults and two sub-adults in the western chamber even though the number for the western chamber is presumably a lot higher.

Western chamber:

Dimensions: 2.75m NS x 2.50m EW, height: 0.8m
Number of burials: MNI 17
Entrance: The entrance to the chambers is narrow and was both formerly blocked by a shallow wall [9021] on the bottom and a larger granite stone plate (75x55x10cm) on top. The stone plates were presumably originally sealed to the wall through mud of which traces are still adhering to the shaft wall above the entrances.
Chamber: The chamber is roughly circular and hewn into the alluvium. The chamber was mainly filled windblown sand and silt rubble covering half of the chamber's height. The first half of the chamber was excavated from outside the chamber,

therefore no stratigraphic information is available for the human remains and finds within the main chamber fill [9019], which contained a large number of disturbed human remains, pot sherds, plaster fragments and wood pieces (see Figures III.47, III.48). The second half of the chamber was excavated in more detail after removal of ceiling of the chamber. Articulated burials Sk201-2, Sk201-3, Sk201-4 and Sk201-5 were placed side by side orientated north-south in extended position.

Ceramics

[9019]	C9008, C9011, C9117, C9118	plate with red-painted rim
	C9009	jar with long neck
	C9010, C9113	beer jar

Finds

[9019]	F9016	scarab in faience with green glaze, long-necked bird with *maat* feather, (l: 1.8cm, h: 0.7cm, w: 1.3cm)
	F9030	plaster fragments, some with red and black paint with imprints of a smooth objects (wall painting?), (max. 5.2x4.6x1.3cm)
	F9034	large amount of unassociated wooden fragments from coffins or beds, BS6
	F9118	fragment of wooden coffin panel with traces of white paint (l: 17.9cm, w: 9.1cm, t: 1.8cm)
	F9119	five wooden fragments (panels) with remnants of white, yellow and red painted decoration (max. 9.8x5.4x2.0cm)
	F9120, F9121	large amounts fragments of worked wood, likely from coffin panels (max. 17.9x4.8x1.5cm)
	F9474	fragments of dark, solid, organic substance, leather or wood, (max. 3x2.6x0.9cm)
	F9475, F9479	fragments of plaster with yellow and black colour, (max. 4.2x1.9x0.8cm)
	F9700	fragments of funerary bed with remnants of the stringing preserved (l: 13.0cm, w: 7.5cm, t: 5.5cm)
	F9701	two fragments of wood with drilled holes (d: 0.6, 0.4cm), (larger piece 7.8x2.2x1.8cm), (small piece 3.5x3.0x1.0cm)
	F9702	fragments of flat wood with remnants of black, red, white and blue pigment (l: 8.8cm, w: 2.6cm, t: 1.4cm)
	F9703	fragments of wood with at least one flat worked surface and at least one small nail in situ (max. 13.6x5.1x2.3cm)
	F9704	six fragments of very light wood (max. 4.3x1.1x0.8cm)

Burials

Sk201-1/ [9174]

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds:

coffin F9471

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 75%

Soft tissue: brain SS32

Sex: male

Age: 25–50 years

Stature: 166.7 ± 0.6cm

Biomolecular: C/O-sample AW16

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	new bone formation on visceral side of 5 right and 4 left ribs
Endocranial changes	-
OA	OA in both ACJ, RCD in both shoulder joints
IVD	n/a
Trauma	small depression fracture on frontal (dm 0.7cm, see Figure III.115), fracture of the left nasal and left 11th rib
Dental pathologies	periapical abscesses on lrI2, lrC, lrP3, llC; slight calculus and moderate periodontitis AMTL (see Figure III.74(inflammatory changes around M3
Other pathologies	-

Dental status

R	M3	x	x	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2*	M3	L
	M3	x	x	x	P3	C	I2	I1	I1	I2	C	x	P4	x	x	M3	

<u>Sk201-2/ [9179]</u>

Funerary ritual

Body Orientation: S–N

Body Position: extended, supine

Associated finds:

F9477	fragments of unknown organic material (leather or wood), (max. 4.4x3.5x1.6cm)
F9478	wooden fragments (max. 4.7x2.3x1.3cm)
F9483	ivory fragments (max. 2.2x0.7x0.2cm)
F9493	plaster fragments from coffin (max. 4.3x2.2x1.0cm)

Skeleton

Articulation: articulated

Bone preservation: 5/2
Completeness: 66%
Sex: male
Age: 20–35 years
Stature: -159.6 ± 1.5
Pathologies:

Orbital lesions	n/a
NBF	right scapula dorsal (active)
Sinusitis	healed NBF in both maxillary sinus as well as frontal sinus
Ribs	mixed NBF visceral in the angle of several ribs (including 11th and 12th) of both sides
Endocranial changes	plaque-like NBF in occipital base
OA	OA in intervertebral joints of cervical and thoracic spine as well as left AJC, RCD in the right humerus
IVD	cervical and thoracic spine
Trauma	
Other pathologies	circular cavitations in small bones of hands and feet potentially indicating gout (see Figure III.105

Dental Status: no teeth

<u>Sk201-3/ [9252]</u>

Funerary ritual
Body Orientation: S–N
Body Position: extended, supine
Associated finds:

F9334	fragments of wood
F9335	fragments of bark
F9490	scarab in steatite with green glaze (1.9 x 1.4 x 0.8cm), base shows a baboon, an erected cobra in front, a *djed*-pillar between the legs, two strokes above its back (netjer nefer?) and one stroke behind

Skeleton
Articulation: articulated
Bone preservation: 4/3
Completeness: 99%
Sex: male?
Age: 35–50 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions
NBF	remodelled and forming NBF in the shaft area of both tibiae and fibulae affecting the entire shaft
Sinusitis	healed NBF in both maxillary sinus as well as frontal sinus

Ribs	visceral side of five right ribs including 11 and 12 and left ribs
Endocranial changes	plaque-like NBF in occipital base
OA	both ACJ, left wrist, both hands, left knee, right ankle and both feet intervertebral joints of thoracic and lumbar spine was well as in the costo-vertebral joints
IVD	cervical vertebrae
Trauma	fracture of spinous process
Dental Pathologies	moderate periodontal disease caries on llM3, abscess on llP4 dental enamel hypoplasias
Other pathologies	cavitations in the tarsals, gout? (see Figure III.106)

Dental Status:

R	-	-	-	-	/	C	I2	I1	x	x	-	-	P4	-	-	M3	L
	-	-	-	-	-	<u>C</u>	-	-	I1	I2	C	P3	P4	x	x	M3	

<u>Sk201-4/ [9253]</u>

Funerary ritual

Body Orientation: S–N

Body Position: extended, prone

Associated finds:

F9494 fragments of wood

F9496 fragments of wood

Skeleton

Articulation: articulated

Bone preservation: 4/2

Completeness: 96%

Sex: male

Age: 20–25 years

Biomolecular: C/N-sample AW4, C/O-sample AW24

Pathologies:

Orbital lesions	n/a
NBF	n/a
Sinusitis	proximal tibia and entire fibula right
Ribs	visceral side of five right and eight left ribs
Endocranial changes	n/a
OA	right ACJ, hip thoracic and lumbar spine

IVD	-
Trauma	fracture of spinous process
Dental pathologies	slight to moderate calculus and periodontal disease caries on llM1-llM3 dental enamel hypoplasia
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- L
	M3	M2	x	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3

Sk201-5/ [9254]

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

F9331	fragments of wood (coffin?)
F9332	fragments of wood (coffin?)
F9333	fragments of white plaster, possibly with some traces of black
F9499	scarab in steatite with green glaze, base shows cartouche of Thutmosis III surround by a feather and erected cobra

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 86%

Soft tissue: remnants of brain tissue SS38

Sex: male

Age: 20–35 years

Stature: 167.7 ± 2.8cm

Biomolecular: C/N-sample AW6

Pathologies:

Orbital lesions	porosities in right orbit, left n/a
NBF	right tibia and fibula entire shaft, left fibula medial third (healed)
Sinusitis	active NBF in both maxillary sinus as well as frontal sinus
Ribs	visceral side of eight right and six left (healed)
Endocranial changes	active NBF of on caudal side of sphenoid right around *Foramen spinosum*
OA	both ACJ, left wrist, both hands, left knee, right ankle and both feet

	intervertebral joints of thoracic and lumbar spine was well as in the costo-vertebral joints
IVD	cervical vertebrae
Trauma	small circular trauma on frontal bone fracture left nasal (see Figure III.115)
Dental pathologies	abscess on ruP3 and ruP4, ulP4, ulM1 slight calculus and periodontal disease
Other pathologies	circular erosions on medial and lateral *os cuneiforme* right, possibly gout

Dental Status

R	x	x	x	P4	P3	C	x	x	/	/	/	/	/	x	x	x	L
	-	-	-	/	P3	/	I2	I1	/	I2	C	P3	/	M1	M2	M3	

Sk201-6/ [9019]

Funerary ritual

Body Orientation: -
Body Position: -
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: 5/2
Completeness: -
Sex: indifferent
Age: 6–7 years
Stature: -
Pathologies: none
Dental Status: no teeth

Sk201-7

Funerary ritual

Body Orientation: -
Body Position: -
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: -
Completeness: -
Sex: indifferent
Age: 10–12 years
Stature: -
Pathologies: no pathologies
Dental Status: no teeth

G243

Orientation: E–W, burial chambers E and W

Superstructure: -
Shaft:

Dimensions: 1.30 EW x 0.50m NS, depth: 1.40m
Number of burials: 1
Description:

A rectangular, narrow shaft, carved vertically into the alluvial silt (cut [9280]) provided entrance to two burial chambers situated on the eastern and western side. Parallel chisel marks as well as a series of small, rectangular foot holes to allow for access to the grave are visible on the northern and southern walls. The small, narrow entrance (h: 0.65m, w: 0.50m), was originally blocked by several schist stones [9283] including a large, vertically placed slab (0.80m height). Mud plaster was used to seal the entrance, even though only remnants remain in situ while the remainder was recovered from within the fill on the bottom of the shaft. The blocking structure of the eastern doorway (h: 0.65m, w: 0.50m, [9284]) comprised several smaller and one large rectangular schist plate, mud bricks and mud plaster. Both structures were partially destroyed by looting activity.

The shaft was entirely backfilled with yellow windblown sand [9281]. In the deeper sections of the deposit, it holds a larger amount of mud brick fragments. A disarticulated burial of a 0.5–1.5 year old infant Sk243–1 was recovered from within the fill on the bottom of the shaft in front of the entrance to the eastern burial chamber. The deposit further holds a number of wooden fragments and disarticulated human remains.

Finds

[9281]	F9175	small powdery traces of wood (max. 3.1x1.4x0.8cm)

<u>Sk243-1/ [9281]</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 41%
Sex: indifferent
Age: 0.5–1.5 years
Stature: -
Pathologies: none

Orbital lesions	strong porosities and NBF

NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	extensive NBF in frontal (woven/porous) appearance
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	NBF in the skull potentially evidence for scurvy (see Figures III.86–88)

Dental Status

R	nE	nE	nE	i2	/	/	/	c	/	/	L
	nE	nE	nE	i2	i1	i1	i2	/	m1	/	

Eastern chamber:

Dimensions: 2.20 x 2.5m NS
Number of burials: 17
Description:

The low, rectangular burial chamber is carved into the alluvial silt [9287] and features straight, vertical walls and even, flat floor. The ceiling had partially collapsed; intact areas indicate it was also straight. The chamber had originally not been backfilled. Windblown sand [9285] entered the chamber through gaps in the partially disturbed blocking structure, covering most of the chamber's content. The deposit is highest adjacent to the entrance, filling the chamber up to 0.40cm of its height. The top of the deposit is very hard and congregated which indicates contact with water. Mixed within the deposit is a large amount of unspecified wooden fragments from funerary containers as well as a large amount of small, skeletal elements which may at least partially have been moved by incoming water. Fragmented, disarticulated bones are further found throughout the chamber with the largest concentration towards the walls which may indicate redeposition of older burials towards the sides of the chamber. Intact and partially intact burials of 16 and one sub-adult individual were recovered from the chamber. All burials were buried in extended position, some prone, some supine. The position of skeletal elements in the intact burial indicates wrapping even though only very few traces of textile were recovered. The burials were superimposed, with up to three individuals on top of each other in the centre of the chamber, leaving doubts as to whether this represents their original burial position but also as to what degree the variable orientation of the burial is significant in terms of funerary ritual. Eight intact vessels were recovered from the western half of the chamber, the majority found in close vicinity to the western wall (see Figure III.47).

Ceramics

[9285]	C9050, C9051, C9052, C9054, C9058, C9061	beer jars
	C9053, C9057	plate with red-painted rim
	C9055	small bottle with red burnish
	C9056/F7228	body sherd of jar, re-used as shovel
	C9060	bowl with red-painted rim

Finds

[9285]	F9176	large amount of un-associated wooden fragmented (max. 14.5x1.0cm)
	F9177	small fragment of rope (l: 1.7cm, d: 0.4cm)
	F9188	fragment of bivalve shell (l: 3.6cm, w: 1.7cm, t: 0.6cm)
	F9193	polished schist stone (l: 18.5cm, w: 1.7cm, t: 8.3cm)
	F9202	ring or hair-ring in form of copper alloy spiral (l: 1.9cm, d: 1.6cm) Figure III.48
	F9204	fragments of wood, some with worked surfaces, belong to unspecified funerary container (max: 11.4x5.1x3.5cm)
	F9205	piece of green schist stone with worn surface (l: 14.2cm, w: 13.0cm, t: 7.4cm)
	F9206	copper alloy tweezers, formed by a strip of metal bent into shape (l: 6.1cm, w: 2.2cm, t: 0.6cm) Figure III.48

Burials

<u>Sk243-2/ [9289]</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, prone

Associated finds:

F9190 doum palm coffin

Skeleton

Articulation: articulated

Bone preservation: 5/3

Completeness: 54%

Sex: indifferent

Age: 36–50 years

Stature: -

Pathologies: none

Orbital lesions	strong porosities
NBF	-
Sinusitis	lamellar NBF in both maxillary sinuses
Ribs	-
Endocranial changes	-
OA	all sections of the spine

	both TMJ, both ACJ, both elbows, left wrist, both hands
IVD	cervical and thoracic spine
Trauma	healed fractures of three consecutive middle ribs at the angle
Dental pathologies	DEH AMTL periapical lesions on lrM1 and lrP3
Other pathologies	-

Dental Status

R	x	x	x	P4	/	x	I2	I1	I1	/	/	/	/	x	x	x	L
	/	x	x	P4	P3	C	I2	I1	I1	I2	C	P3	x	x	x	x	

Sk243-3/ [9290]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F9196 textile fragments

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 60%

Sex: female

Age: 30–40 years

Stature: 161.6 ± 0.6cm

Pathologies:

Orbital lesions	vessel impressions and hypertrophy
NBF	-
Sinusitis	healed changes in both maxillary sinuses
Ribs	visceral on at least three right and left middle ribs, healed
Endocranial changes	-
OA	all sections of the spine right TMJ, both ACJ, right elbow, both wrists, right knee
IVD	all sections of the spine
Trauma	two small sub-circular depression fractures on the frontal bone healed fracture of nasal bone
Dental pathologies	caries DEH moderate calculus and periodontitis periapical lesions on llI2, llC, llP3
Other	small circular abscess in nasal cavity left

	calcified structure (see Figures III.144, III.145)

Dental status

R M3	M2	M1	P4	x	C	I2	I1	I1	I2	C	P3	P4	M1	x	x	L
x	x	x	x	P3	/	I2	/	/	/	/	x	x	x	x	/	

Sk243-4/ [9291]

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

F9183 textile fragments

F9189 dark wooden remnants of coffin

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 86%

Soft tissue: brain tissue SS50

Sex: indifferent

Age: 36–50 years

Stature: 160.7 ± 2.2cm

Pathologies:

Orbital lesions	vessel impressions
NBF	remodelled on both tibiae lateral and both fibulae along entire shaft
Sinusitis	remodelled NBF in both sinuses
Ribs	healed changes on five right middle and upper ribs
Endocranial changes	-
OA	all sections of the spine both ACJ, both elbows, right hip, right knee, right ankle and foot
IVD	cervical and lumbar spine
Trauma	healed fracture of distal ulna left healed fracture of sternal end of one right rib
Dental pathologies	caries DEH moderate calculus and periodontal disease periapical lesions on lrP4, lrC, lrI2, lrI1
Other pathologies	RCD

Dental status

R	/	/	/	/	P3	C	I2	I1	/	x	C	P3	/	x	/	M3	L
	x	x	x	/	x	C	I2	I1	I1	I2	C	P3	P4	x	x	x	

Sk243-5/ [9293]

Funerary ritual

Body Orientation: SW–NE

Body Position: extended, prone

Associated finds:

F9185 traces of textile

F9186 wooden fragments

Skeleton

Articulation: articulated

Bone preservation: 5/4

Completeness: 48%

Sex: female

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	healed NBF on the sides of the orbit
NBF	remodelled changes on both tibiae (medial and lateral) and fibulae
Sinusitis	remodelled changes in both maxillary sinuses
Ribs	visceral on at least four left ribs of the lower area including the 11^{th}
Endocranial changes	-
OA	thoracic spine right shoulder, both elbows, left wrist, both hands, left hip, right foot
IVD	cervical spine
Trauma	-
Dental pathologies	caries AMTL DEH
Other pathologies	RCD

Dental status

R	M3	M2	-	-	-	x	x	x	x	x	x	P3	P4	-	-	-	L
	x	x	x	-	-	-	-	-	-	-	-	-	-	x	x	x	

Sk243-6/ [9292]

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

F9184	textile fragments
F9189	doum palm coffin fragments

Skeleton

Articulation: partially articulated

Bone preservation: 5/2

Completeness: 42%

Sex: male

Age: 20–30 years

Stature: 160.7 ± 3.3cm

Pathologies:

Orbital lesions	vessel impressions and NBF in orbital roof
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	remodelled changes in both maxillary sinuses
Ribs	-
Endocranial changes	-
OA	cervical and thoracic spine right elbow and hip, left knee (with OCD)
IVD	cervical spine
Trauma	healed fracture on right phalanx foot
Dental pathologies	DEH moderate calculus and periodontal disease
Other pathologies	SN in thoracic and lumbar spine

Dental Status

R	/	/	/	P4	P3	C	I2	-	-	/	C	/	P4	-	-	-	L
	x	x	x	/	/	C	I2	I1	-	-	-	-	-	-	-	-	

Sk243-7/ [9296]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 30%
Sex: female
Age: 21–35 years
Stature: 157.7 ± 3.1cm
Pathologies:

Orbital lesions	vessel impressions and healed NBF in the orbital roof
NBF	on the both tibiae along entire shaft (healed)
Sinusitis	n/a
Ribs	-
Endocranial changes	small granular impressions on skull base, occipital and in greater sphenoid wings
OA	left hand
IVD	n/a
Trauma	-
Dental pathologies	moderate dental calculus and periodontal disease periapical lesion on ulP4
Other pathologies	-

Dental Status

R	-	-	-	-	-	/	/	I1	/	/	x	P3	P4	x	x	x	L
	x	x	x	/	x	x	x	x	x	x	x	x	/	x	x	x	

Sk243-8/ [9298]

Funerary ritual
Body Orientation: N–S
Body Position: extended, supine
Associated finds:

F9191 wooden fragments of coffin, unclear material
F9192 traces of textile

Skeleton
Articulation: articulated
Bone preservation: 4/3
Completeness: 80%
Soft tissue: remnants of brain (SS51)
Sex: male
Age: 36–50 years
Stature: 171.4 ± 1.2cm
Pathologies:

Orbital lesions	porosities in left orbit
NBF	active changes on body of S3 remodelled on both tibiae (medial and lateral) and fibulae along

	entire shaft
Sinusitis	healed NBF in both maxillary sinuses and sphenoid sinus
Ribs	remodelled changes visceral on at least four upper and middle ribs
Endocranial changes	healed NBF in both greater sphenoid wings on bottom in jugular fossa
OA	all sections of the spine both ACJ, right shoulder, left elbow, both wrists, right hand, left hip, right knee, right ankle, both feet
IVD	lumbar and cervical spine
Trauma	vertebral body fractures on L3 and L4
Dental pathologies	caries moderate calculus and periodontal disease DEH periapical lesions on uric, rlI1, ulP4, ulM1 and lrI1 NBF surrounding abscess on urC
Other pathologies	RCD

Dental Status

R M3	M2	M1	P4	P3	C	x	/	/	I2	/	P3	P4	/	M2	M3	L
M3	M2	x	P4	/	/	I2	I1	I1	I2	C	/	/	x	M2	M3	

Sk243-9/ [9301]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F9194 coffin fragments, wood and plaster

F9203 steatite scarab with green glaze, depicting three animals: a bull or a rhino, a feline and a lizard, (l: 1.6cm, w: 1.3cm, t: 0.8cm)

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 72%

Sex: male

Age: 21–35 years

Stature: 163.6 ± 2.8cm

Pathologies:

Orbital lesions	vessel impressions
NBF	NBF on the both tibia and both fibulae (healed) entire shaft
Sinusitis	n/a
Ribs	remodelled visceral on at least six middle and lower left and right ribs

Endocranial changes	NBF with active small patches along sagittal sinus and in frontal
OA	cervical, thoracic and lumbar spine right clavicle, left shoulder, right elbow
IVD	all sections of the spine
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental Status

R	/	/	/	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	/	P4	P3	C	I2	I1	/	/	C	P3	P4	M1	M2	M3	

<u>Sk243-10/ [9300]</u>

Funerary ritual

Body Orientation: E–W

Body Position: extended, prone

Associated finds:

F9195 wood from coffin, species undetermined

F9203 scarab in green faience, seated goddess Maat with feather on the head, seat baboon, solar disc, (l: 1.4cm, w: 1.2cm, t: 0.7cm)

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 66%

Sex: female

Age: 21–35 years

Stature: 155.5 ± 1.9cm

Pathologies:

Orbital lesions	porosities, vessel impression and NBF in the roof of both orbits
NBF	NBF on both tibiae lateral
Sinusitis	left maxillary sinus
Ribs	healed visceral on at least five right and five left middle and lower ribs
Endocranial changes	increased vessel impressions in occipital bone
OA	thoracic spine left elbow, right wrist and hand, left knee, both feet
IVD	cervical and lumbar spine
Trauma	healed fracture of one left middle rib on shaft

Dental pathologies	DEH caries periapical lesions on ulI1, ulP4
Other pathologies	SN in thoracic spine

Dental Status:

R /	M2	M1	/	/	/	/	/	/	x	C	x	P4	x	x	-	L
M3	x	x	-	-	-	-	-	/	/	C	x	x	x	x	x	

Sk243-11/ [9302]

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds:

F9197 doum palm coffin

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 56%

Sex: female

Age: 36–50 years

Stature: 161.1 ± 2.9cm

Pathologies:

Orbital lesions	strong vessel impressions in both orbits
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	strong changes on the endocranial side Figure III.98
OA	lumbar spine both ACJ, right knee
IVD	lumbar spine
Trauma	-
Dental pathologies	periapical lesions on ulC, ulM3 caries AMTL
Other pathologies	-

Dental Status

R	/	/	/	/	P3	/	/	I1	x	/	/	P3	/	M1	M2	x L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sk243-13/ [9304]

Funerary ritual

Body Orientation: W–E

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 6/1

Soft tissue: Brain tissue (SS55)

Completeness: 45%

Sex: female

Age: 21–35 years

Stature: 152.7 ±1.6cm

Pathologies:

Orbital lesions	-
NBF	both tibiae proximal and distal shaft, both fibulae medial and distal shaft
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	lumbar spine both hips and knees
IVD	lumbar spine
Trauma	small depression fracture, healed
Dental pathologies	-
Other pathologies	SN in lumbar spine

Dental Status: no teeth

Sk243-14/ [9303]

Funerary ritual

Body Orientation: NE-SW

Body Position: extended, supine

Associated finds:

F9200 textile fragments

Skeleton

Articulation: articulated
Bone preservation: 5/3
Completeness: 81%
Sex: female
Age: 6–10 years
Stature: -
Pathologies:

Orbital lesions	-
NBF	woven on mandibular ramus woven on distal right humerus, both tibiae in mid-shaft
Sinusitis	n/a
Ribs	visceral woven on four right ribs
Endocranial changes	-
OA	cervical, thoracic and lumbar spine
IVD	-
Trauma	small depression fracture, healed
Dental pathologies	DEH caries on deciduous teeth
Other pathologies	-

Deciduous teeth

R	m2	m1	/	/	/	/	/	/	m1	m2	L
	-	-	-	-	-	-	-	-	-	-	

Permanent teeth

R	-	ne	M1	P4	ne	C	I2	I1	I1	/	ne	ne	ne	M1	ne	-	L
	-	ne	M1	ne	P3	C	I2	I1	I1	I2	/	P3	P4	M1	ne	-	

<u>Sk243-17/ [9305]</u>

Funerary ritual

Body Orientation: E–W
Body Position: extended, supine
Associated finds:

F9199 coffin fragments, wood unspecified
F9201 small textile fragments

Skeleton

Articulation: articulated
Bone preservation: 5/3
Soft tissue: hair (SS57), brain tissue (SS56)

Completeness: 75%
Sex: female
Age: 20–35 years
Stature: 161.2 ± 0.6cm
Biomolecular: C/O-sample AW35
Pathologies:

Orbital lesions	-
NBF	severe NBF in mandible labial
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine right ACJ and hand
IVD	cervical spine
Trauma	healed fracture of shaft of 12th rib left
Dental pathologies	DEH mild to moderate calculus and periodontal disease caries
Other pathologies	-

Dental Status

R	<u>M3</u>	<u>M2</u>	x	/	P3	C	I2	I1	I1	I2	C	/	/	x	M2	x	L
	-	M2	M1	/	/	C	I2	I1	I1	I2	C	P3	P4	M1	M2	-	

<u>Sk243-18/ [9306]</u>

Funerary ritual
Body Orientation: NE–SW
Body Position: extended, supine
Associated finds:

F9207 plaster fragments, potentially from coffin

Skeleton
Articulation: articulated
Bone preservation: 5/2
Completeness: 26%
Sex: female
Age: 36–50 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-

Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	cervical, thoracic and lumbar spine both ACJ, right shoulder, both elbows, right wrist and hand, both hips, knees, ankles and feet
IVD	cervical, thoracic and lumbar spine
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

<u>Sk243-19/ [9307]</u>

Funerary ritual

Body Orientation: S–N

Body Position: extended, prone

Associated finds:

F9208 scarab in blue faience, depicting two rearing cobras and a *djed*-pillar between them, (l: 2.1cm, w: 1.5cm, t: 1.0cm)

F9209 rope

Skeleton

Articulation: articulated

Bone preservation: 5/3

Completeness: 75%

Sex: indifferent

Age: 36–50 years

Stature: 166.3 ± 2.0cm

Pathologies:

Orbital lesions	remodelled NBF in both orbital roofs
NBF	remodelled NBF nasal cavity and on nasal process of maxilla infraorbital remodelled on both tibiae (medial) and fibulae along entire shaft
Sinusitis	-
Ribs	remodelled NBF visceral on at least five right lower ribs
Endocranial changes	increased vessel impression and NBF endocranially associated with ectocranial trauma
OA	cervical, thoracic and lumbar spine right TMJ, both ACJs, right shoulder, both elbows, both hands, right hip

IVD	cervical, thoracic and lumbar spine
Trauma	depression fracture on right parietal fractures of L3, L4 and L5 healed fracture of right 2nd metatarsal 2nd, 3rd and 4th left and two right middle ribs healed on right proximal clavicle
Dental pathologies	caries DEH mild-–moderate dental calculus and periodontal disease
Other pathologies	-

Dental Status

R M3	M2	M1	P4	P3	C	/	/	/	x	/	/	P4	M1	/	/	L
x	x	x	/	/	C	/	/	/	/	C	/	/	x	x	x	

Sk243-20/ [9310?]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 30%

Sex: female

Age: indifferent

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk243-21/ [9309]

Funerary ritual

Body Orientation: N–S
Body Position: extended, supine
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: 5/2
Soft tissue: skin? (SS60, SS61)
Completeness: 40%
Sex: indifferent
Age: 20–30 years
Stature: 157.6 ± 1.9cm
Pathologies:

Orbital lesions	vessel impressions in both orbital roofs and NBF on walls of left orbit
NBF	remodelled changes on both tibiae (medial and lateral side) along entire shaft, right fibula distal remodelled in nasal cavity
Sinusitis	-
Ribs	-
Endocranial changes	strong granular impressions on occipital base and frontal base
OA	both knees
IVD	-
Trauma	-
Dental pathologies	AMTL caries DEH mild–moderate calculus and periodontal disease periapical lesions on urP4
Other pathologies	-

Dental Status

R	x	x	x	P4	P3	C	-	-	x	x	C	P3	P4	x	x	M3	L
	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Western chamber:

Dimensions: 1.40m EW x 1.80m NS, height: 0.90m
Number of burials: 4
Description:

The western burial chamber is markedly smaller than the eastern chamber, with a sub-circular outline, a low, curved ceiling and rounded side walls carved into the alluvial silt [9288]. One articulated burial of a young adult male was recovered partially within the shaft, partially within the chamber, either resulting from looting or lack of space within the chamber. The chamber was equally left unfilled; a deposit of intrusive yellow windblown sand filled about half the chambers height [9376]. The back of the chamber holds a pile of entirely disarticulated skeletal remains from one adult and two sub-adult individuals. No pottery or wooden fragments were recovered from this chamber.

Sk243-12/ [9375]

Funerary ritual

Body Orientation: E–W

Body Position: extended, on left side

Associated finds:

F9610 69 circular beads in green faience, (t: 0.2cm, d: 0.5cm)

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 82%

Sex: female?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions and healed NBF in both orbital roofs
NBF	NBF on both tibiae (medial, healed)
Sinusitis	-
Ribs	visceral on shaft of six right ribs including 11th and 12th and three left middle ribs
Endocranial changes	plaque-like NBF in frontal bone (see Figure III.98)
OA	cervical, thoracic and lumbar spine right ACJ and elbow, both hands
IVD	cervical and lumbar spine
Trauma	healed fracture of a medial phalanx of the hand
Dental pathologies	calculus and periodontal disease caries DEH periapical lesions on urC, urI1, ul1, ulC, llP4
Other pathologies	SN in lumbar spine

Dental Status

R	x	x	x	P4	/	/	/	I1	I1	/	C	/	/	x	x	x	L
	x	x	x	P4	P3	/	I2	I1	/	I2	C	P3	/	x	M2	/	

Sk243-15/ [9376]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 44%

Sex: female

Age: 20–25 years

Stature: 159.0 ± 2.0cm

Pathologies:

Orbital lesions	porosities, hypertrophy and remodelled NBF
NBF	both fibulae along entire shaft (healed)
Sinusitis	n/a
Ribs	visceral remodelled on two right and three left ribs
Endocranial changes	extensive small granular impressions in frontal base, deep vessel impressions along the *A. meningea media*
OA	cervical and lumbar spine left ACJ
IVD	cervical spine
Trauma	-
Dental pathologies	caries (see Figure III.70) DEH mild to moderate calculus and periodontal disease periapical lesion on ulM2 (see Figure III.71)
Other pathologies	SN in lumbar spine

Dental Status

R	M3	M2	M1	P4	P3	C	/	/	/	I2	C	P3	P4	M1	M2	M3	L
	M3	x	x	P4	P3	/	/	/	/	/	C	P3	/	x	M2	M3	

Sk243-16/ [9376]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 31%

Sex: indifferent
Age: 5–6 years
Stature: -
Pathologies:

Orbital lesions	porosities in both orbital roofs
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH on permanent teeth caries on deciduous teeth
Other pathologies	-

Deciduous dentition

R	m2	m1	C	/	i1	/	/	/	m1	m2	L
	-	-	-	-	-	-	-	-	-	-	

Deciduous dentition

R	-	-	ne	/	/	C	/	I1	I1	I2	/	ne	ne	/	ne	/	L
	-	ne	/	/	ne	/	ne	/	/	ne	/	/	/	/	ne	/	

Sk243-25/ [9376]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 6/1
Completeness: 34%
Sex: indifferent
Age: adult
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-

Endocranial changes	-
OA	cervical spine
IVD	cervical spine
Trauma	
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

Post-New Kingdom niche burials

G203

Orientation: EW, niche north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.60m EW x 0.70m NS, depth: 0.35m
Description:
The shaft was filled with windblown sand mixed with a small amount of silt [9011]. No pottery or other finds were recovered from this grave.

Niche:

Dimensions: 1.40m EW x 0.70m NS, height 0.40m
Description:
The fill of the niche [9011] consisted of windblown sand and traces of alluvial silt and held the disturbed and entirely disarticulated remains of an infant.

Ceramics: -
Finds: -

<u>Sk203</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 44%
Sex: indifferent
Age: 2–2.5 years
Stature: -
Pathologies: none

Dental status: no teeth

G204

Orientation: unclear, eroded
Number of burials: 1

Superstructure: -
Shaft: eroded (?)

Niche:

Dimensions: 0.70m EW x 0.80m NS, preserved depth: 0.15m

The roughly round pit, possibly representing remnants of an eroded niche was carved vertically into the alluvial silt. While the southern part of the burial was disturbed with a fill mainly consisting of windblown sand [9014], the northern part was undisturbed with the articulated head and torso of the infant embedded in a solid layer of silt gravel [9051]. The burial position of the infant is hard to determine due to the disturbance of the lower extremities even though the alignment of the preserved skeletal parts suggests a west-east-orientation. -

Ceramics:

C9012 small black burnished bowl (see Figure III.58)

Finds: -

<u>Sk204</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3

Completeness: 33%

Sex: indifferent

Age: neonate

Stature: -

Pathologies: none

Orbital lesions	-
NBF	fibula right
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

G205

Orientation: E-W, niche north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: shaft d: 1.0m, depth: 0.30m

Niche:

Dimensions: 1.05m x 0.90m, depth: 0.40m
Description:

G205 consists of a small round subterranean burial niche. The niche faces south with the north wall forming a little step. The grave was disturbed, with only a few isolated bones scattered in the windblown sand which made up the fill. The entrance was originally sealed by diagonally placed mud bricks of which only three bricks remain in situ.

The disturbed, but generally well preserved remains of an infant were found loosely scatted in the fill of the grave. Due to the disturbance, no inferences can be made about the burial position or orientation of the burial.

Ceramics: -
Finds: -

<u>Sk205</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 60%
Sex: indifferent
Age: 0.5–1 years
Stature: -
Pathologies:

Orbital lesions	porosities and NBF
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	-

Trauma	-
Dental pathologies	-
Other pathologies	

Dental status

R	-	-	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	<u>dM1</u>	<u>dM1</u>	

G206

Orientation: E–W, niche north?
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.80 EW x 0.65 NS, depth: 0.40m
Description:
G206 is a simple, rectangular pit carved into the alluvium. The southern edge is slightly stepped, indicating that the pit represents remnants of an eroded niche. The fill [9039] consisted windblown sand in the upper part and silt in the lower part of the pit. Attached to the western and eastern wall of the grave were two slumps of mud, probably representing remnants of a covering structure.

Ceramics: -
Finds: -

<u>Sk206</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/2
Completeness: 9.5%
Sex: indifferent
Age: 12–18 years
Stature: -
Pathologies: none
Dental Status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	<u>C</u>	-	-	-	-	-	<u>P3</u>	-	-	-	-	

G208

Orientation: E–W, niche north
Number of burials: 1

Superstructure: -
Shaft/ Niche:

Dimensions: depth: 0,30m
Description:
G208 is a small, elongated oval-shaped, very shallow burial pit cut into the alluvium. The northern wall is slightly undercutting the surface while the southern wall is sloping in an angle of ~45° which might suggest interpretation as eroded niche burial. The pit was disturbed and solely filled with windblown sand [9043]. It contained no finds except for disarticulated human remains.

Ceramics: -
Finds: -

Sk208

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 27%
Sex: indifferent
Age: 2–3 years
Stature: -
Pathologies:

Orbital lesions	porosities bilateral
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

G210

Orientation: E–W, niche south
Number of burials: 4

Superstructure:

Dimensions: d: 9.5–10.0m
Description:
The superstructure of the tomb [9028] comprises a low tumulus, consisting of mudbrick, covered with dark schist stones.

Shaft:

Dimensions: l: 1.80cm, w: 0.70m depth: 0.95m
Description:
The shaft [9023] is rectangular, vertically carved into the alluvial silt and filled with windblown sand [9022] containing disarticulated human remains from the burials within the niche.

Ceramics -

Finds

[9022]	F9010	Sandstone door lintel, carved with columns and lines of hieroglyphic inscription on one face, (l: 140cm, w: 55cm, t: 10cm)

Niche:

Dimensions: l: 1.90m, w: 0.65m, h: 0.30–0.40m
Description:
The niche was originally sealed with rectangular sandstone block F9010 (see Figure III.21) which was identified as re-used door lintel bearing hieroglyphic inscriptions. The palaeography is consistent with a dating to the Ramesside period and it seems very likely that it was taken from somewhere in the town.
The niche [9023] is rectangular, carved into the alluvial silt. The fill of the niche [9025] consists of windblown sand mixed with a little bit of silt broken away from the sides. The niche was disturbed and contained the heavily disarticulated, commingled remains of four individuals. Finds are confined to several beads, a fragment of a bracelet of Egyptian blue F9014 (see Figure III.59) and some unidentifiable wooden remains which were scattered loosely in the fill.

Ceramics:

[9025]	C9106	bowl
	C9107	base of a jar

Finds

[9025]	F9011	five bone disc beads (d: 0.3cm, t: 0.1cm), five faience disc beads (d: 0.2cm, t: 0.1–0.2cm), one cylindrical faience bead (l: 1.1cm, t: 0.2cm)
	F9014	fragment of bracelet from Egyptian blue, (t: 0.6cm, d: 6.0cm)

Burials

Sk210-1

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 43%
Sex: female
Age: 21–35 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions
NBF	-
Sinusitis	n/a
Ribs	n/a
Endocranial changes	NBF in frontal and along sagittal sinus, small patch with white surface
OA	n/a
IVD	n/a
Trauma	small sharp trauma (1-2cm) on frontal bone
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk210-2

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 52%
Sex: male
Age: 20–25 years
Stature: -

Pathologies:

Orbital lesions	vessel impression on left side, right side normal
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	NBF in frontal and along sagittal sinus, small patch with white surface
OA	-
IVD	-
Trauma	small sharp trauma (1-2cm) on frontal bone
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

<u>Sk210-3</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 49%
Sex: indifferent
Age: 3–4 years
Stature: -
Pathologies:

Orbital lesions	NBF on roof, walls and floor of both orbits
NBF	n/a
Sinusitis	n/a
Ribs	n/a
Endocranial changes	deep vessel impression, slight, localized new bone formation
OA	n/a
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	stellate lesions on endocranial side of skull potentially scurvy (see Figures III.82, III.83)

Dental Status: no teeth

<u>Sk210-4</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/2
Completeness: 46%
Sex: -
Age: 5–7 years
Stature: -
Pathologies:

Orbital lesions	NBF on roof, walls and floor of both orbits, strong porosities
NBF	n/a
Sinusitis	n/a
Ribs	n/a
Endocranial changes	new plaque-like bone formations and increased impressions of the blood vessels
OA	n/a
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	stellate lesions on endocranial side of skull, scurvy? (see Figures III.84, III.85)

Dental Status: no teeth

G211

Orientation: E–W, niches on northern side, burial chamber on the western side
Number of burials: 10

Superstructure: -
Shaft:

Dimensions: 2.30m EW x 1.10m NS, depth 1.80m
Description:

The shaft [9030] is rectangular, EW-orientated and vertically cut into the alluvial silt. The shaft was filled with windblown sand [9026] up to a depth of 1.20m, indicating that the shaft was not backfilled. The deposit held a small amount of pot sherds and several isolated human bone fragments as well as some large schist stones presumably deriving from blocking chamber of the western chamber which were displaced during looting of the chamber. In addition, a decorated bone plaque (F9100) and several elements of wooden Finds, among them two coffin fragments bearing traces of plaster and red and yellow paint (F9122) were recovered. The bottom of the shaft was filled with a dense layer of debris from destroyed blocking structure from the chamber [9045], reaching a thickness of 0.3-0.4m. The deposit was void of finds.

Ceramics		-
Finds		
[9026]	F9100	bone plaque
	F9122	coffin fragments with red and yellow painted plaster

Upper Niche:

Dimensions: 1.10m EW x 0.55m NS, depth: 0.25m
Number of burials: 1
Description:

On top of the shaft, adjacent to the northern wall of the shaft of G211, there is another, small oval-shaped burial pit carved into the alluvial silt [9032]. The shallow pit is again east-west orientated and held the disturbed remains of an infant Sk211-1. Leaning to the southern wall of the burial pit were two vertically placed schist stone plates [9031], likely representing remnants of some kind of blocking structure. It was backfilled with windblown sand [9029] which was void of any finds.

Lower Niche:

Dimensions: 1.90m EW x 0.60m NS, depth: 0.40m
Number of burials: 1
Description:

The lower burial niche [9047] is carved into the northern wall on the bottom of the shaft. It was sealed by a large schist stone plate [9027] (1.75 x 1.0m) which was still in place at the time of the excavating. Gaps between the niche and the wall were sealed but mud plaster of which was largely intact on the eastern side of the shaft. On the western side, the mud plaster was removed by looters in order to gain excess to the burial without removing the schist plate. Thence, the burial within the niche was only disturbed in the head and neck area to the east while the rest of the skeleton remained intact. Due to the weight of the stone plate which left it difficult to remove, only the western (head) end of the burial inside the niche was disturbed because it could be reached from outside. The niche behind the stone was partly backfilled with windblown sand [9033] which does not cover the entire height of the niche.

The niche contained one intact skeleton Sk211-2, buried in an extended position with the head in the west. The body was completely wrapped in at least two different layers of woven matting, a coarse outer one and thin inner layer adhering to the body, of which large parts were preserved. Some preserved soft tissue was recovered as well. The burial was placed on a wooden burial bed (F9082) of which parts of the frame and stringing were preserved. The only other grave goods recovered from the niche were a fragment of a bone plaque and one cornelian bead (F9081) recovered from the fill.

<u>Sk211-2/ [9033]</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds:

F9081	cornelian bead, bone plaque
F9082	wooden burial bed
F9084	coarse matting wrapped around the skeleton

Skeleton

Articulation: articulated, head missing

Preservation: 6/1

Completeness: 86%

Soft tissue: soft tissue in shoulder area SS6, hair SS7

Sex: male

Age: 25–35 years

Stature: 163.0 ± 1.6cm

Biomolecular: C/O-sample CB9033 (Purdue)

Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	left sinus (healed)
Ribs	healed new bone formation on the visceral side of left and right ribs
Endocranial changes	-
OA	upper thoracic and lumbar vertebrae right ACJ and elbow, as well as both wrists
IVD	-
Trauma	fractures on the right transverse processes of L3 and L4
Dental pathologies	extensive dental abscesses in right side of mandible new bone formation within bone along the channel of *nervus alveolaris & mentalis* moderate calculus and periodontal disease
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	/	/	/	/	/	M1	M2	M3	L
	/	M2	M1	/	/	C	I2	/	I1	I2	C	/	x	M1	M2	M3	

Western burial chamber

Dimensions: 1.25m EW x 1.80m NS, depth: 0.80m
Number of burials: 6
Description:

The rectangular burial chamber with vertical straight walls [9041], a flat bottom and ceiling is situated on the western side of the shaft, extending to the north and carved into the alluvial silt. It's narrow, rectangular entrance (w: 0.8m, h: 0.7m, depth: 0.2m) was originally sealed by a shallow wall made of schist stone plates and mud bricks on the bottom [9035]. The top had been removed; three schist stone plates likely belonging to this structure were recovered within the shaft.

The chamber was backfilled with windblown sand [9034], the content of the chamber could only be recovered commingled. Among the finds from the western chamber (see Figures III.50–III.51) were again a large number of wood fragments of which some could clearly be identified as parts of funeral furniture. Some of those fragments were covered with a white plaster of which some still bore traces of paint. Further finds of the burial chamber involved fragments of possible matting used to wrap the corpses, beads, amulets and pot sherds. Unfortunately, as the chamber was heavily disturbed and it was not possible to enter the chamber due to safety reasons none of the finds was recovered in situ.

Ceramics -

Finds

[9034]	F9046, F9051, F9065, F9126, F9689, F9691, F9693	large amount of wooden fragments belonging to coffin or funerary bed
	F9048, F9127	fragments of funerary bed with parts of stringing preserved, (l: 16cm, w: 5.7cm, t: 3.3cm)
	F9049	situla in faience with blue-green glaze, two parallel lines of black décor dived by vertical lines, (h: 10.4cm, d: 4.4cm)
	F9050	object from degraded limestone or faience, (l: 2.3cm, w: 1.1cm, t: 1.2cm)
	F9053	tweezers in copper alloy, (l: 3.3cm, w: 1.3cm, t: 0.4cm)
	F9054	shell, one half of bivalve shell, (l: 8.2cm, w: 3.2cm, t: 0.9cm)
	F9060, F9063	two faience amulet in form of Hathor head, (h: 1.8cm, w: 1.1cm, t: 0.4cm)
	F9061	three bracelet plaques in bone or ivory (l: 1.7–1.9cm w: 1.1cm, t: 0.2-0.3cm)
	F9062	group of beads: four biconical bone beads (l: 0.6–0.9cm), four spherical lapis lazuli beads (d: 0.5cm) and a sub-spherical red quartz/carnelian bead (d: 0.2cm)
	F9068. F9073	plaster fragments of varying sizes with red and yellow décor
	F9069	oval faience bead with blue glaze, (l: 1.0cm, t: 0.5cm, d: 1.3cm)
	F9070	eight bi-conical cornelian beads (d: 0.4cm) and one

	rectangular bone plaque (l: 1.8cm, w: 1.4cm, t: 0.3cm)
F9074	cylindrical wooden element of a funerary bed with remains of incised decoration (l: 4.2cm, d: 1.7cm)
F9123, F9128	matting fragments
F9132	eight fragments of mud plaster with one surface bearing painted decoration
F9686	large amount of small fragments of reed basketry
F9687	small fragments of branches or wood wrapped with a thin layer of straw (l: <5.0cm, d: 0.9cm)
F9688	three fragments of rope
F9690	fragments of twigs, possibly cross beams
F9692	fragment of wooden bed terminal (l: 4.7cm, w: 5.8cm, t: 1.8cm)
F9728	fragments of textile, (l: <4.0cm)
F9729	bed terminal with square shaped bottom (decorated with circular lines) and circular element on top, (h: 7.0cm, w: 4.5cm, t: 3.5cm)

Burials

<u>Sk211-3/ [9034]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 6/1

Completeness: 57%

Sex: female

Age: 36–50 years

Stature: 156.4 ± 1.5cm

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	cervical, thoracic and lumbar spine
IVD	-
Trauma	small depression fracture, healed
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

Sk211-4/ [9026], [9034]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness:
Sex: -
Age: 2–3 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk211-5/ [9026], [9034]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/1
Completeness:
Sex: -
Age: neonate
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk211-6/ [9034]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 35%

Sex: female

Age: 21–35 years

Stature: 157.6 ± 1.3cm

Pathologies:

Orbital lesions	vessel impressions and porosities
NBF	left fibula
Sinusitis	n/a
Ribs	-
Endocranial changes	NBF in sphenoid sinus
OA	lower thoracic spine
IVD	-
Trauma	-
Dental pathologies	abscess on ulI2, urI2 moderate dental calculus and slight periodontal disease DEH
Other pathologies	-

Dental Status

R	-	-	M1	P4	/	/	I2	/	/	I2	/	/	/	x	M2	M3	L
	M3	M2	/	/	/	/	I2	/	/	/	/	/	P4	M1	M2	M3	

Sk211-7/ [9034]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3, some soft tissue adhering to the remains

Completeness: 50%

Sex: male

Age: > 36 years

Stature: 162.1 ±2.7cm

Pathologies:

Orbital lesions	vessel impressions in both orbital
NBF	remodelled NBF on both tibiae medial and lateral (see Figure III.90)
Sinusitis	lamellar NBF in both orbits and frontal sinus
Ribs	-
Endocranial changes	-
OA	both ACJ and shoulders (including signs of impingement and RCD), right elbow and wrist all sections of the spine
IVD	cervical and lumbar spine
Trauma	healed oblique fractures on the left humerus, right radius, ulna and acromion (Figure III.129, III.130) small healed depression fracture on the left parietal (d: 2.5cm) with slight remodelled inflammatory changes surrounding the margin
Dental pathologies	severe AMTL large conjoining periapical lesions on ulI1–ulC with drain into oral cavity, periapical lesions on urM2, u3M1, urP4, urP3, ulP4 and llI2
Other pathologies	button osteoma (d: 0.7cm) on left parietal

Dental Status

R	-	x	/	/	x	/	x	/	/	x	x	x	/	x	x	x	L
	/	x	x	x	/	/	/	/	/	x	x	x	x	x	x	x	

Sk211-8/[9034]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness:
Sex: male
Age: 36–50 years
Stature: 167.7 ± 3.7cm
Pathologies:

Orbital lesions	n/a
NBF	unilateral remodelled new bone formation on the right femur and right tibia
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	OA in both ACJ, shoulder (RCD and impingement), right elbow and wrist (secondary to fracture) all sections of the spine
IVD	thoracic spine
Trauma	healed hairline fracture across the distal joint surface of the right radius
Dental pathologies	caries DEH moderate calculus and periodontal disease
Other pathologies	-

Dental Status

R	/	<u>M2</u>	/	/	/	<u>C</u>	<u>I2</u>	<u>I1</u>	/	<u>I2</u>	/	/	/	/	/	/	L
	M3	M2	x	/	/	C	I2	I1	I1	I2	C	P3	P4	x	M2	x	

G214

Orientation: E–W, niche: south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.20–2.40m EW x 1.40m NS, depth: 0.70–0.80m

Description:

Due to surface erosion and instability of the alluvial silt, much of the height of the shaft may have been lost and the outline of the originally rectangular shaft [9104] is rather irregular with large parts of ceiling having caved in. Chisel marks were visible on the northern, eastern and western side. The bottom of the shaft is only slightly raised in relation to the niche. The fill of the shaft [9105] mainly consists of windblown sand fill. The bottom of the shaft was covered with remnants of mudplaster and large schist stone plates [9106] presumably deriving from the disturbed covering structure. Disarticulated human remains were recovered from the shaft already. In addition, smaller, unidentifiable fragments of leather and wood, as well as two tail bones of an unidentified mammal (F9573), potentially belonging to the same object as (F9573) recovered from within the niche, were found scattered in the fill.

Ceramics	-
Finds	
F9305, F9306	leather or tissue fragments (<2.0cm)
F9307	wooden fragments belonging to an unknown object (<2.0cm)
F9311	two fragments of animal bones (3.3x1.1x0.6cm; 2.4x0.8cm) and one small complete bivalve shell (0.7x0.4cm)
F9573	two tail bones of large ungulate (1: 1.7 x 0.5cm 2: 1.5 (fragment) x 0.8cm)

Niche:

Dimensions: 2.20-2.30m EW x 1.10m NS, height: 0.50m

Description:

The low burial niche [9109], carved into the southern side of the shaft was equally filled with windblown sand [9107], and covered remnants of the blocking structure (schist slabs, mudplaster [9108]) as well as disarticulated remains of one adult individual. The ceiling of the niche had largely broken away. Position of the remains tentatively suggests an E–W orientation with head in the east. Remnants of grave goods comprise possible leather fragments (F9303, F9304), small unidentifiable wooden fragments as well as two tail bones of an unidentified mammal (F9574).

Ceramics	-
Finds	
F9303, F9304	leather or tissue fragments (<2.0cm)
F9309	wooden fragments belonging to an unknown object (<2.0cm)
F9574	tail bones of large ungulate

<u>Sk214</u>

Funerary ritual

Body Orientation: E-W

Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 67%
Sex: male
Age: 21–35 years
Stature: 164.9 ± 4.7cm
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic spine left ACJ
IVD	cervical spine
Trauma	-
Dental pathologies	caries DEH moderate calculus
Other pathologies	SN in the lower thoracic spine

Dental Status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	-	-	-	-	P4	C	-	-	I1	I2	C	-	-	M1	-	-	

G215

Orientation: E-W, niche: north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.70 EW x 0.80m NS, depth 0.35m
Description:
G215 features a small, oval to rectangular shaped grave cut [9152], vertically carved into the alluvial silt. Traces of parallel chisel marks are visible on all sides. The bottom of the shaft is uneven, sloping step-like into a small niche on the northern side of the shaft. The backfill consisted of windblown sand [9153]. Three large, heavily eroded sherds (~15cm) recovered from the bottom of the shaft were presumably used as tools while robbing the grave. Several small schist

plates recovered from the surface surrounding the tomb potentially represent remnants of a niche-blocking structure.

Niche:

Dimensions: 1.05 EW x 0.75m NS, depth: 0.40m
Description:
The small burial niche [9154] is cut into the northern side of the shaft. The ceiling is largely missing due to erosion of the surface. The bottom of the niche is slightly lower than in the shaft, the walls are rather rounded. The fill equally consists of windblown sand [9152] which is void of any finds.

G216

Orientation: E–W, niche north
Number of burials: 6

Superstructure: -
Shaft:

Dimensions: 2.60 x 1.30m, depth: 0.85m
Descriptions:
The shaft [9155] is rectangular, E–W aligned and vertically cut into the alluvial silt. The shaft was filled with deposit [9156], consisting of windblown sand mixed with slit rubble (<10%). It holds fragments of plaster (<3cms) and schist stones of less than 5cm length. Disarticulated and commingled remains of additional individuals were recovered from the shaft of the grave, among them remnants of a newborn child. The deposit further holds a large number of sherds which join with sherds found within the niche (see Figure III.61).

Ceramics		
[9156]	sherd used as shovel	
	large number of sherds from at least four bowls and jars	
[9060]	C9144	bowl with red painted rim
	C9145	red-slipped bowl
Finds		
[9060]	F9453	wooden fragments (largest fragment: 3.6x2.7x1.9cm)
	F9456	shell bead (l: 3.1cm, w: 1.7cm, t: 1.0cm)

<u>Sk216-2</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2

Completeness: 74%
Sex: -
Age: neonate
Stature: -
Pathologies: none

Dental Status: -

Niche:

Dimensions: 2.60 x 1.10 – 1.20m, depth: 0.70m
Description:

A single large slab (0.77x0.60x0.12m) [9166] remained in place from the original covering of the grave, with further fragments recovered from the within the disturbed fill of the shaft. The niche was re-used for at least five consecutive interments. At least three of them were buried in a decorated wooden coffin (F9457), with only the last burial Sk216-1/ [9167] being partly intact while the disarticulated bones of the two previous burials were found scattered on the bottom of the coffin [9169]. Disarticulated remains of two more individuals were found scattered on the bottom of the niche and shaft. [9168]. G216 is exceptional in terms of finds (see Figure III.62).; in contrast to the other niche burials it contained a fairly large assemblage of grave goods including jewellery items such as two necklaces – one of shell disc-beads and semi-precious stone beads, the other of blue tubular faience beads with a large biconical ivory bead and a *nerita* shell in between - a copper alloy bracelet (F9465) and three amulets. Due to the looting of the tomb, associating the objects with any of the individuals was not possible. Two amulets are made of faience, and depict. Isis suckling the Horus-the-Child (F9466) and Pataikos (F9467); the third one is a Bes amulet carved in ivory (F9453).

Ceramics		
[9165]	C9140-C9143	bowls with red-painted rim
Finds		
[9165]	F9455	large amount of wooden fragments (one of the largest 4.5x1.6x1.0cm)
[9168]	F9459	Bes figure in ivory (l: 4.2cm, w: 1.8cm, t: 1.3cm)
	F9460	small orange bead of cornelian or glass (l: 0.7cm, d: 0.5cm)
[9169]	F9457, F9458	wooden coffin decorated with painted plaster
	F9462	21 circular ostrich egg shell beads (0.4x0.1cm), one cylindrical cornelian bead (0.6x0.4cm)
	F9463	copper alloy bracelet, (d: 6.0cm, t: 0.3cm)
	F9464	necklace from a large amount of ostrich egg shell (d: 0.4cm) and cornelian beads (d: 0.7cm)
	F9465	group of beads: one bi-conical ivory bead (2.3x1.0cm), a nerita shell bead 1.7x1.5x1.1cm), 32 cylindrical faience beads (l:0.9cm, d: 0.4cm), 28 circular faience beads (d: 0.4cm)
	F9466	blue faience amulet of Isis with Horus child (h: 4.2cm, w: 1.3, t:

	1.6cm)
F9467	small amulet of Pataikos (h: 3.5cm, w: 1.5cm, t: 1.1cm)
F9468	parts of wooden small branch, largest fragment (l: 6.5cm, w: 2.5cm)
F9469	textile fragments (largest fragment 1.5x1.1x0.3cm)
F9470	ivory bead in shape of a duck, (l: 1.9cm, h: 1.0cm, w: 0.9cm)

<u>Sk216-1/ [9167]</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds:

F9547	coffin
F9548	coffin

Skeleton

Association: partly disarticulated

Bone preservation: 5/2

Completeness: 84%

Sex: female

Age: 20–30 years

Biomolecular: C/O-sample AW10

Stature: 161.2 ± 2.0cm

Pathologies:

Orbital lesions	n/a
NBF	bilateral new bone deposition on both femoral shafts medial and lateral with horizontal vessel impressions medial, both fibulae
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic spine, both ACJ and right elbow joint
IVD	-
Trauma	healing fractures of vertebral bodies of Th11-L1 and spinous process of Th6 and Th7 (see Figure III.128) 1st right rib in mid-shaft area, the sternal end of two left ribs (3-8th) and on the *angulus costae* of one right rib, two healed fractures on two left ribs (3-8th)
Dental pathologies	slight calculus and periodontal disease, caries on left M^1 and M^3, periapical lesions on urC and ruI^1
Other pathologies	-

Dental Status

R M3	/	M1	/	/	/	x	I1	x	x	/	P3	P4	M1	M2	M3 L
x	x	x	x	x	-	-	-	-	-	-	P3	x	x	x	x

Sk216-3/ [9169]

Funerary ritual

Body Orientation: W–E (?)

Body Position: extended?

Associated finds:

F9547 coffin

F9548 coffin

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 46%

Sex: indifferent

Age: 17–20 years

Biomolecular: C/O-sample AW14

Stature: 156.0 ± 1.3cm

Pathologies: -

Dental Status: no teeth

Sk216-4/ [9169]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/2

Completeness: 33%

Sex: female

Age: 21–35 years

Stature: 154.4 ± 1.8cm

Pathologies:

Orbital lesions	Porosities in the right orbital roof with NBF on the lateral walls and floor of both orbitae
NBF	remodelled new bone formation on both tibia shafts (medial and lateral)
Sinusitis	lamellar NBF in both sinuses
Ribs	

Endocranial changes	Small granular impressions in base of frontal bone and greater sphenoid wing
OA	
IVD	
Trauma	
Dental pathologies	Caries on urP^4 and ulM^1 Dental enamel hypoplasia Periapical lesions on ulM^1, ulM^2
Other pathologies	-

Dental status

R M3	x	x	P4	P3	C	I2	I1	I1	I2	C	P3	/	M1	M2	/	L
/	/	/	/	/	/	/	/	/	/	/	/	/	/	x	x	

Sk216-5/ [9168]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 39%

Sex: female

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	strong vessel impressions in both orbitae
NBF	
Sinusitis	
Ribs	
Endocranial changes	small vessel impressions and very deep, large impressions of *A. meningea media* with patches of NBF
OA	OA in the right acetabulum
IVD	
Trauma	
Dental pathologies	Periapical lesions on ulP3, ulM1, llC, llP3 Caries on ulP^3, llP^3, llP^4 Active NBF
Other pathologies	-

Dental Status

R	-	-	-	-	x	/	/	/	/	/	/	P3	/	x	-	- L
	-	-	-	-	-	-	-	-	I1	I2	C	P3	/	x	/	M3

Sk216-6/ [9168]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: Disarticulated

Bone preservation: 5/2

Completeness: 10%

Sex: male

Age: middle adult

Stature: -

Pathologies:

Orbital lesions	strong vessel impressions and NBF in both orbital roofs
NBF	-
Sinusitis	active NBF in maxillary sinus
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	Periapical lesions Active NBF surrounding llM3
Other pathologies	-

Dental Status:

R	x	x	x	x	/	x	x	/	/	x	x	x	x	x	x	x L
	-	-	-	-	-	-	-	-	I1	I2	C	P3	/	x	/	M3

G217

Orientation: E-W, niche: north

Number of burials: 1

Superstructure: -

Shaft:

Dimensions: 0.80-1.40m EW x 0.60-0.70m NS, depth: 0.50m
Description:
The grave features a small rectangular shaft with vertical walls carved into the alluvial silt [9113]. The bottom of the shaft is flat. The grave was backfilled with windblown sand [9111]. Scattered within the fill were unidentifiable fragments of leather or tissue and disarticulated remains of an infant concentrated in the west end of the context. Remnants of a blocking structure were confined to a few fragments of mudplaster scattered in the fill as well as some parts still adhering to the wall of the shaft cut.

Niche:

Dimensions: 0.9m EW x 0.34m NS, height: 0.30m
Description:
The small burial niche is located on the northern side of the shaft and is situated 0.20m deeper that the shaft. The uneven, rounded walls appear to be largely intact, with visible angular tool marks on the side walls (cut [9117]). It was backfilled with clear, windblown sand [9118]. Remnants of one infant burial were recovered scattered within the shaft. Grave goods are confined to small, unidentifiable parts of wood (F9321) and an organic substance possibly representing leather (F9323).

Finds

[9118]	F9321	small fragments of wood (max 1.2x0.7x0.2cm), BS160
	F9323	small fragments of leather or un-identified organic substance (max 1.9x1.9x1.3cm), BS169

Sk217

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 9%
Sex: -
Age: 0–0.5 years
Stature: -
Pathologies: none
Dental Status: -

G218

Orientation: E–W, niche: south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.80 EW x 1.10m NS, depth: 0.56m
Description:

The grave, carved entirely in alluvial silt features a rectangular shaft [9056] with vertical walls which are slightly sloping towards the bottom. The shaft is filled with windblown sand [9057], holding disturbed sherds of post-New Kingdom date. Three schist stones (0.23x 0.49 x 0.4m; 0.18 x 0.17 x 0.10m; 0.13 x 0.23 x 0.02cm, [9065]) likely represent displaced remnants of covering structure.

Niche:

Dimensions: 1.70m EW x 0.90m NS, height: 0.40m
Description:

The burial niche on the northern side of the shaft [9060] is rectangular with rounded edges. The fill consists windblown sand [9061], mixed with little bit of alluvial silt. Inside the niche, disarticulated remains of one adult male were recovered. Sherds of 6 vessels (one pilgrim flask, three bowls and two jars), a small shell F9138, fragments of skin or leather F9137 and one tail bone of an unidentified animal (cattle?, F9575) were also found loosely scattered within the fill.

Ceramics

[9061]	fragments of a pilgrim flaks, a red slipped jar, another jar and three red-rimmed bowls

Finds

[9061]	F9137	small fragments of leather or un-identified organic substance (max 1.9x1.9x1.3cm)
	F9138	small shell (k: 1.9cm, d: 0.8cm)
	F9575	one tail bone of a larger ungulate animal (l: 2.4cm, d: 0.4cm)

<u>Sk218</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/3
Completeness: 27%
Sex: male
Age: 21–35 years

Stature: 163.8 ± 2.4cm
Pathologies:

Orbital lesions	strong vessel impressions and NBF in both orbital roofs
NBF	-
Sinusitis	active NBF in maxillary sinus
Ribs	remodelled new bone formation on the visceral side of three right ribs
Endocranial changes	-
OA	OA in the mid-thoracic spine, SN in the mid-thoracic spine
IVD	IVD in the cervical and lumbar spine
Trauma	healed trauma, possibly caused by sharp force on the left side of the frontal bone
Dental pathologies	Moderate dental calculus and periodontal disease DEH Periapical lesion on ulM3, lrM1, lrM2, llM1
Other pathologies	-

Dental Status

R	M3	M2	x	P4	P3	C	I2	/	I1	I2	C	P3	P4	x	x	M3	L
	-	-	-	-	-	-	-	-	I1	I2	C	P3	/	x	/	M3	

G219

Orientation: E–W, niche: south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.80m EW x 0.74m NS; depth: 0.25m
Description:

The small vertical shaft of G219 is rectangular with rounded edges (cut [9058]). The bottom is flat, sloping down into a small burial niche on the southern side of the shaft. It was filled with clean windblown sand [9059]. The base of a pilgrim flask was recovered from the fill.

The covering structure of the niche [9064] was intact on the eastern side of grave, consisting of diagonally placed schist plates, sealed with mud plaster. Fragments of destroyed covering structure were recovered from both the shaft and the niche of the burial.

Ceramics

[9059] base of a pilgrim flask

Niche:

Dimensions: 1.90m EW x 0.40m NS, height: 0.2m

Description:

The burial niche is rectangular and carved into the alluvial silt on the southern side of the shaft (cut [9062]). The bottom is flat; the ceiling is not intact as substantial parts of the ceiling were presumably lost due to erosion. It was backfilled with windblown sand [9063] and contains the disarticulated remains of one adult individual (Sk219). Grave goods are confined to fragments of a jar and bowl with red-painted rim.

Ceramics

[9062] rim of red-rimmed bowl and fragments of one jar

Finds

[9062] F9136 fragments of shell (max. 1.5x1.5cm)

Sk219

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 26%

Sex: indifferent

Age: adult

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	OA in the cervical, upper thoracic and lumbar spine and in the phalanges of the feet
IVD	IVD in the cervical spine
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

G220

Orientation: E–W, niche north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.10m EW x 1.10m NS, depth: 0.40m
Description:

The shaft is rectangular, with vertical, on the bottom slightly sloping walls carved into the alluvial silt. The walls are generally rather friable, the northern wall has partly broken away creating a relatively irregular outline. Few chisel marks were visible on the walls. The bottom is flat, descending into the burial niche on the northern side. The shaft fill [9111] consists of windblown sand. Disarticulated remnants of an adult individual were found scattered on the bottom of the shaft, concentrated in the northern and western part of the tomb. The only semi-articulated portion consisted of a few phalanges of the hand found in close proximity of scaraboid (F9312). Unidentifiable fragments of one or more wooden objects as well as two small beads (F9310) were also found loosely distributed in the shaft of the tomb. Only one large schist slab (0.45x0.70m) and several fragments of mud plaster bearing imprints of stones remain from original covering structure. Several large schist plates recovered in the surrounding of the grave may represent additional elements of this destroyed covering structure.

Finds

[9110]	F9310	two beads from stone (1.2x1.0cm) and blue faience (1.1x0.4cm)
	F9312	light green amulet in faience in shape of a stela, representing a baboon, inscription on the other side “Khonsou, who was a child, lord of Maat”, (l: 1.7cm, w: 1.3cm, t: 0.7cm)
	F9314	fragments of mud plaster lid of a vessel (max. 6.7x5.1x2.7cm)
	F9315	large amount of leather or other organic substance (max. 2.4x1.6x.1.6cm)
	F9316	small fragments of wood from unknown object (max. 2.0x1.0x0.6cm)
	F9317	small spherical shell (0.5x0.3cm)
	F9318	pieces of white plaster from unknown object (max. 2.6x2.2x1.4cm)

Niche:

Dimensions: 2.20m x 0.50m, height: 0.35m
Description:

The ceiling of the small burial niche was largely destroyed due to collapse and surface erosion and only remained intact on the northern side. The bottom is flat. It was also backfilled with windblown sand [9115], containing a small amount of disarticulated human bones and fragments of wood.

<u>Sk220</u>

Funerary ritual
Body Orientation: -

Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 16%
Sex: female
Age: adult indet.
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	OA in the upper thoracic spine and right ACJ
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

G221

Orientation: E-W, niche: north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.50m EW x 0.70m NS, depth: 0.20m
Description:
G221 features a rectangular, vertical shaft with slightly rounded edges (cut [9066]). The bottom is flat, moderately sloping down towards the burial niche carved into the northern side of the tomb. The fill [9067] was clean, windblown sand without any further finds.

Niche:

Dimensions: 2.20m EW x 0.34m NS, depth: 0.15m
Description:
The narrow burial niche is roughly rectangular with rounded edges (cut [9068]); the walls and ceiling are only partly intact with large parts having broken away. It

was filled with windblown sand mixed with fragments from the side walls [9069]. The burial Sk221 recovered within the niche was disturbed and entirely disarticulated. The bones are not well preserved, very light and fragile and don't represent the complete skeleton. Remnants of grave goods are confined to one fragment of fabric (F9139).

Finds

[9069] F9139 fragments of fabric (max. 1.4x1.0x0.5cm)

Sk221

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 8%

Sex: indifferent

Age: 12–15 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

G222

Orientation: E-W, niche: north

Number of burials: 1

Superstructure: -

Shaft:

Dimensions: 0.90m NS x 2.05m EW, depth 0.90m

Description:

The grave features a rectangular, east-west aligned grave shaft cut vertically into the alluvial silt (cut [9162]). The side walls are straight, the bottom is flat. Clear chisel marks can be seen on all sides of the shaft. The shaft is only backfilled with windblown sand [9163].

Mudbricks and pieces of mudplaster ([9175]) deriving from the mud brick wall which originally sealed the burial niche were scattered across the bottom of the shaft. The bottom of the shaft was filled with 10cm of debris of disturbed burial content [9176], containing remnants of a wooden coffin decorated with plaster painted in red, yellow and black (F9472) and fragments of two vessels.

Finds

[9176]	F9472	plaster with red, yellow and black colour (max. 4.2x2.8x2.2cm)
	F9468	wood fragments (max. 3.1x1.4x.0.7cm)

Niche:

Dimensions: 2.0m EW x 0.70m NS, height: 0.40m

Description:

The narrow burial niche [9177] is rectangular with rounded side walls displaying chisel marks. It is situated only slightly deeper than the shaft with a short, vertical step. The bottom of the niche is roughly even. In contrast to most other niche burials the cut is entirely intact. It is filled with a disturbed layer of sand, alluvial silt rubble and debris of the destroyed sealing structure. The adult buried within the niche was completely disturbed and disarticulated except for the right hand which remained articulated. Its position strongly suggests a W-E aligned burial. Fragments of a destroyed wooden coffin (F9474) and painted plaster (red or blank white mainly, few pieces of yellow and black (F9487) were recovered from within the fill. Further fragments of very fine painted plaster were recovered adhering to the northern wall of the niche. The side of the plaster facing the niche bears imprints of wood, thus they are most likely representing remnants of a coffin.

Finds

[9178]	F9484	leather fragment with small holes (max. 3.4x2.5x1.4cm)
	F9486	fragments of painted plaster, bottom of coffin, with remnants of red, black and yellow stripes (max. 2.7x1.9x0.2cm)
	F9572	plaster fragments with yellow and red colour (max. 4.2x3.1x1.3cm)

<u>Sk222</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4
Completeness: 29%
Sex: indifferent
Age: >36 years
Stature: -
Pathologies:

Orbital lesions	NBF in the left orbital roof
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	OA in the cervical, thoracic and lumbar spine, the left wrist and both knees
IVD	IVD in the cervical spine
Trauma	healed fracture of the right 5th metacarpal
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

G224

Orientation: E–W, niche: north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.10m EW x 0.70m NS, depth: 0.20m
Description:

Rectangular shaped grave with vertical walls carved into the alluvial silt (cut [9071]). The bottom of the shaft is sloping towards the little niche carved into the northern wall. Shaft and niche were backfilled with windblown sand [9072]. Disarticulated remains of the disturbed infant burial were recovered loosely scattered in the windblown sand both in the shaft and niche.

Niche:

Dimensions: 1.93m EW x 0.33m NS, depth: 0.30m
Description:

The small rectangular burial niche [9073] is only slightly undercutting but most of the roof may have disappeared due to surface erosion. The niche was also backfilled with a deposit of yellow windblown sand [9074]. Except for disarticulated human remains, the niche was void of any finds.

Sk224

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 43%
Sex: male
Age: 16–20 years
Biomolecular: C/O-sample AW9
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

G226

Orientation: SE–NW, niche: north
Total number of burials: 7

Superstructure:

Dimensions: 7.50m x 6.40m
Description:
The superstructure [9075] consists of a low circular mound of alluvial silt loosely covered by black schist stones around the shaft.

Finds

[9075] F9152 grind stone (l: 11.9cm, w: 9.5cm, t: 3.8cm)

Shaft:

Dimensions: 1.94m EW x 1.0m NS, depth: 0.65m

Description:

The shaft is rectangular with rounded edges vertically carved into the alluvial silt (cut [9076]). The bottom of the shaft is flat, sloping down into the niche towards the northern side. It was filled with windblown sand, containing completely disarticulated remains of five adult individuals and two infants which presumably removed from the shaft during re-use or disturbance of the burial. Sherds of at least 6 vessels including the neck of a pilgrim-flask C9017 (see Figure III.63) as well as a wooden bed leg (F9141) were also recovered from within the shaft.

The niche covering structure [9080], consisting of one large schist stone plate orientated SE–NW (1.12x0.14x0.04m) and a series of vertically upright placed smaller schist stones (0.49–0.69x0.10–0.17x0.04–0.07m) had largely been destroyed.

Finds

[9077]	F9142	large amount of small fragments of leather or skin (max. 2.1x1.6x1.6cm)
	F9468	wood fragments (max. 3.1x1.4x.0.7cm)

Niche:

Dimensions: 1.88m EW x 0.66m NS, depth: 0.30m

Description:

Shallow, rectangular-shaped burial niche with rounded edges cut into the northern side of the shaft [9078]. The roof had largely collapsed or eroded away. The niche had flat base, in contrast to most other niche burials, the niche is not significantly lower in respect to the shaft. It was backfilled with windblown sand [9077]. The adult female individual Sk226-1/ [9079] inside the niche was largely complete, with only the skull and right humerus disarticulated and displaced within the fill of the shaft. The burial was placed in an extended, supine position, orientated E–W, the left arm crossing over the right arm. The body was placed on a wooden burial bed (F9146). It was accompanied by two baskets (F9143, F9144, see Figure III.62), both placed at the left foot end, faience necklace or bracelet (F9145) and a miniature vessel C9018 placed inside the basket (F9144). Disarticulated elements of six more individuals burials were found disarticulated on the bottom of the niche and shaft.

Finds

[9078]	F9173	purple glass bead (l: 1.5cm, w: 0.8cm t: 0.5cm)

Burials

<u>Sk226-1/ [9079]</u>

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds:

C9018 miniature jar, marl clay
F9143 basket, (d: 14.0cm)
F9144 basket, (d: 11.0cm)
F9145 necklace of 61 circular green faience beads (d: 0.4cm)
F9146 funerary bed

Skeleton
Articulation: articulated
Bone preservation: 6/1
Completeness: 96%
Soft tissue: brain SS23
Sex: female
Age: 21–35 years
Stature: 159.6 ± 2.9cm
Pathologies:

Orbital lesions	n/a
NBF	remodelled NBF on both tibiae medial and lateral along the entire shaft as well as on the right fibula
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	costovertebral joints on the left and right side (Th6, Th8–12), lower thoracic spine, TMJ, right wrist
IVD	-
Trauma	healed fractures of the left 11th and 12th rib
Dental pathologies	caries on lrM1 active NBF on both mandibular ramus and on the alveolar rim possibly in relationship to AMTL
Other pathologies	-

Dental Status:

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	x	x	M1	P4	/	/	/	/	/	I2	/	/	/	/	x	x	

Sk226-2

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/2

Completeness: 30%
Sex: indifferent
Age: 10–15 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	active on right tibia distal
Sinusitis	n/a
Ribs	active visceral on right 12th rib
Endocranial changes	n/a
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk226-3

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 37%
Sex: indifferent
Age: 1–2 years
Stature: -
Pathologies:

Orbital lesions	-
NBF	active on the shaft of the right tibia
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	-
Trauma	-

Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk226-4

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: Disarticulated

Bone preservation: 5/2

Completeness: 17%

Sex: -

Age: 6–7 years

Stature: -

Pathologies:

Orbital lesions	porosity and hypertrophy in the orbits (see Figure III.78)
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk226-4

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: Disarticulated

Bone preservation: 4/2

Completeness: 38%
Sex: -
Age: 6–8 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk226-6

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/2
Completeness: 43%
Sex: female
Age: 36–50 years
Stature: 161.6 ± 2.5cm
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	OA in the thoracic spine

IVD	IVD in the cervical and upper thoracic spine
Trauma	healed fractures on the distal third of the left clavicle vertebral body fractures of Th3, Th5 and Th11 (see Figure III.127) fracture of the right lower articular facet on Th9
Dental pathologies	-
Other pathologies	osteoporosis

Dental Status:

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	-	-	x	x	x	x	x	x	x	-	-	-	-	-	-	-	

Sk226-7

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 19%

Sex: female

Age: >30 years

Stature: 153.5 ± 2.0cm

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	lumbar spine, right ACJ, left elbow, both wrists, left hip and both feet
IVD	lumbar spine
Trauma	vertebral body fracture of L4 (see Figure III.125) healed fracture on the left distal ulna shaft, "Colles' fracture" of the right radius (see Figure III.131)
Dental pathologies	AMTL
Other pathologies	

Dental Status:

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	x	x	/	x	x	x	x	x	

G227

Orientation: E–W, niche: north
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.0m EW x 1.10m NS, depth: 0.50m
Description:

The grave features a small, oval shaped, vertical shaft. The bottom is flat, descending step-like into a small burial niche on the northern side of the shaft. The only remnants of a covering structure are traces of mud plaster adhering to the top of the bench and the side walls arching upwards from the bench towards the top of the niche.

Niche:

Dimensions: 1.95m EW x 0.66m NS, height: -
Description:

The burial niche is roughly rectangular, carved into the alluvium on the north side of the shaft of G227 (cut [9120]). A large amount of collapse has rendered the niche almost roofless and some of the existing roof collapsed during excavation when the fill [9123] was removed the niche itself also appears to be uneven, with the floor sloping upwards from immediately north of the bench to the northern most extent of the cut. While the western side of the niche is more rectangular, the eastern corner is rounded. The ceiling of the niche is not intact anymore. Niche fill for G227 consisted predominantly of yellow windblown sand with large amounts of mud rubble and mud plaster debris. The burial inside the niche was disturbed, disarticulated bones of an adult individual were recovered loosely scattered in the niche and shaft. Due to the roof collapse, it was not possible to separate the fill originating from the roof. Wood fragments (F9322) and pieces of painted plaster (F9325) suggest the presence of a coffin.

Finds

[9123]	F9322	wooden fragments from coffin, BS95, BS170 (max. 2.7x0.9x1.2cm)
	F9324	large amounts of small fragments of leathery substance, BS164
	F9325	painted plaster fragments

<u>Sk227</u>

Funerary ritual
Body Orientation: -

Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 40%
Sex: female
Age: 36–50 years
Stature: 157.6 ± 4.5cm
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	active and remodelled NBF on the visceral side of the vertebral ends of 1 right rib (very fragmentary so possibly more)
Endocranial changes	n/a
OA	thoracic and lumbar intervertebral and costo-vertebral joints, left ACJ and shoulder, right hand
IVD	thoracic and lumbar spine
Trauma	-
Dental pathologies	-
Other pathologies	

Dental Status: no teeth

G228

Orientation: E–W, niche south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.0m EW x 1.30m NS, depth: 0.45m
Description:

The grave features a vertical, rectangular shaft with rounded edges (cut [9081]). Base of shaft is flat, stepping vertically down into the burial niche. It was filled with yellow windblown sand mixed with traces of alluvial silt rubble [9082]. Disarticulated human bones deriving from the burial inside the niche were scattered throughout the shaft. The niche had originally been covered by a large schist plate (1.67x0.62x0.08m, [9085]) which was displaced into the shaft during looting of the burial.

Niche:

Dimensions: 2.0m EW x 0.80m NS, height: 0.35m

Description:

The burial niche is rectangular; its ceiling appeared largely intact (cut [9083]). It was entirely filled with yellow windblown sand [9084]. The burial was found completely disarticulated. Woven reeds (F9151) possibly represent remnants of matting used for the burial.

Finds

[9084] F9151 plant or wooden remains, BS107

<u>Sk228</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 62%

Sex: male

Age: 36–50 years

Stature: 167.3 ± 1.7cm

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine
IVD	-
Trauma	-
Dental pathologies	
Other pathologies	

Dental Status:

R	-	-	-	-	P4	C	I2	I1	I1	I2	C	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

G230

Orientation: E-W, niche: south
Number of burials: 2

Superstructure: -
Shaft:

Dimensions: 1.75m EW x 0.75m NS, depth: 0.50m
Description:

The shallow grave features a rectangular, vertical shaft carved into the alluvial silt (cut [9124]). In contrast to most other niche burials, shaft and niche are on the same level. It was backfilled with windblown sand [9125] with silt and debris from the destroyed covering structure being scattered throughout the deposit. Disarticulated, commingled human remains deriving from several individuals were recovered from the bottom of the tomb. Finds from the shaft comprise three heavily eroded sherds, a very small amount of charcoal, remnants of a yet unidentified organic material as well a small blue faience bead (F9329), all of them presumably deriving from the disturbed burial niche.

Finds

[9125]	F9328	large amount of small fragments of leather or skin (max. 5.0x3.6x2.9cm)
	F9329	small circular faience bead (d: 0.3cm, t: 0.1cm)

Niche:

Dimensions: 1.80m EW x 0.25m NS, depth: 0.20m
Description:

The rectangular burial niche, carved into the southern side of the shaft is very narrow (cut [9128]). The ceiling was not intact- The walls of the cut are almost vertical. The backfill of the burial niche consisted entirely of windblown sand [9129], containing some inclusions of debris from the collapsed ceiling and mud plaster from the destroyed covering structure. The content of the burial niche [9129] was found completely disturbed. It was used for the burial of two adult individuals whose remnants were entirely disarticulated and commingled with no anatomical relationships being recorded present. Painted plaster and wooden fragments suggests the presence of a coffin. In addition, small fragments of an organic substance, possibly leather were recovered from the niche.

Finds

[9125]	F9330	large amount of small fragments of leather or skin (max. 2.2x1.4x1.0cm), BS168

Burials

<u>Sk230-1/ [9129]</u>

Funerary ritual
Body Orientation: -
Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: 4/4
Soft tissue: brain SS31
Completeness: 30%
Sex: female
Age: 36–50 years
Stature: 154.7 ± 3.9cm
Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	active and remodelled NBF in the left maxillary sinus
Ribs	-
Endocranial changes	-
OA	slight degenerative changes on the vertebral bodies (only cervical and few lumbar preserved
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

<u>Sk230-2/ [9129]</u>

Funerary ritual

Body Orientation: -
Body Position: -
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: -
Completeness: 42%
Sex: female
Age: >50 years
Stature: 163.6 ± 0.7cm
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-

Endocranial changes	n/a
OA	lower thoracic and lumbar spin right ACJ, left elbow and right ankle
IVD	lower thoracic spine
Trauma	healed fracture of the left 2nd metatarsal
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

G233

Orientation: E-W, niche: south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 2.0m EW x 1.0m NS, depth: 0.55m
Description:

The grave features a rectangular-shaped cut with rounded edges (cut [9090]). The base is flat, vertically stepping down into the burial niche on the southern side of the burial. It was backfilled with windblown sand [9091]. The covering structure for the niche, consisting of a large schist stone plate [9094] (dimensions: 185x68x7cm) had been opened. Remnants of mud plaster applied to seal the structure were recovered from the bottom of the shaft and are also visible on the side walls of the shaft above the niche.

Niche:

Dimensions: 1.96m EW x 0.76m NS, height: 0.30m
Description:

The rectangular burial niche [9092] carved into the southern side of the shaft. The niche is situated lower than bottom of the shaft, creating a step-like profile. The burial niche was fully disturbed and backfilled with windblown sand [9093]. It contained the disarticulated remains of one single burial (Sk233). Grave goods (see Figure III.64) were recovered scattered all over the niche, including one red-burnished bowl (C9139), sherds of another bowl and a second, heavily eroded vessel, faience and quartz beads (F9153) and an ivory needle F9150.

Finds

[9093]	F9150	ivory needle with one end carved in spiral form (l: 11.1, d: 0.7cm)
	F9153	small amount of beads: spherical quartzite (0.8x0.6cm), two circular ostrich eggshell (0.5x0.1cm), one circular green faience (0.6x0.2cm), two circular brown faience (0.4x0.1cm), five spherical purple glass

	beads (0.5x0.3cm)
F9154	eight beads in green faience: six circular (d: 0.7cm, t: 0.3cm), two cylindrical (d: 0.7, l:0.8cm)

Sk233

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 54%
Sex: indifferent
Age: 15–18 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	lamellar NBF visceral on one right and two left ribs
Endocranial changes	granular impressions in the occipital and skull base
OA	possible OA in one thoracic vertebra
IVD	-
Trauma	-
Dental pathologies	slight dental calculus DEH
Other pathologies	-

Dental Status

R	-	-	-	P4	P3	-	-	-	-	I2	C	-	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	-	-	C	-	P4	M1	M2	M3	

G236

Orientation: E–W, niche: south
Number of burials: 1

Superstructure:

Dimensions: d: 5.0m
Description:

The superstructure [9206] comprises a low mound built up of alluvial silt. On top of superstructure loose scatter of schist stones.

Shaft:

Dimensions: 0.80m EW x 0.60m NS, depth: 0.30m

Description:

Small, oval grave cut [9207] with rounded edges orientated east-west, carved vertically into the alluvial silt. The bottom is flat, sloping down into to the niche. The shaft was backfilled with a deposit of loose, windblown sand [9208].

Niche:

Dimensions: 0.65m EW x 0.35m NS, height: 0.25m

The niche is small and oval shaped with a flat base (cut [9209]). Southern side is undercutting with a moderate break of the slope at the base. The burial within the niche was completely disarticulated and mixed within the backfill of loose yellow windblown sand mixed with traces of alluvial silt [9210].

<u>Sk236</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 21%

Sex: indifferent

Age: neonate

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-.
Endocranial changes	.
OA	.
IVD	.
Trauma	.
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

G237

Orientation: E–W, niche: north
Number of burial: 1

Superstructure: -
Shaft:

Dimensions: 2.20m EW x 0.60m NS; depth: 0.60m
Description:

This tomb appears to have large parts of the original backfill [9183] consisting of alluvial silt rubble intact. Only a smaller, narrow cut which was backfilled with windblown [9189] sand indicates disturbance of the burial. Two large, heavily eroded sherds recovered from the cut likely represent shovels. The shaft of the grave [9184] is oval-shaped, narrow and vertically carved into the alluvial silt
The burial niche was covered with a row of almost vertically placed schist slabs [9182] leaning towards the northern face of the shaft. The gaps between the slabs were sealed with mud plaster. Some mud plaster fragments on top of the structure display traces of finger prints. While the western half is entirely intact, some parts were broken open on the eastern side.

Ceramics

[9189] two large eroded ceramic sherds used as shovels

Niche:

Dimensions: 2.15m EW x 0.65m NS, depth: 0.40m
Description:

The shallow burial niche, carved into the northern side of the shaft is of oval shape (cut [9184]). The ceiling is not intact anymore, with most parts having collapsed. Parallel chisel marks are visible on the side walls. It is only slightly lower than the bottom of the shaft with a flat base. The upper half of the niche was backfilled with windblown sand [9185] while the lower part and content of burial niche was covered by collapse from the ceiling [9196] indicating that the niche itself had not been backfill. The middle adult female Sk237 [9197] inside the niche was largely intact, only the head area was disturbed with the skull missing. She was buried in a fully extended body position with head in the east. The right arm was extended alongside the body with hand over pelvis, while left forearm was crossed over the gut area. The position of the skeletal elements suggests tight wrapping of the body, remnants of textile (F9505) adhering to the body were preserved. The wooden remains surrounding the skeleton (F9489), planks along north, east and south side, bed legs (F9501 & F9504) suggest presence of a funerary bed which was decorated with very thin layer of white plaster. One intact bowl with a red-painted rim (C9036) was placed on top of the individuals gut. Further sherds from at least one jar were recovered from the disturbed layer above the burial.

Ceramics

[9196]	C9036	red rimmed bowl
Finds		
[9185]	F9488	wooden fragments from burial bed

Sk237/ [9197]

Funerary ritual

Body Orientation: W-E

Body Position: extended, supine

Associated finds:

F9489	wooden funerary bed
F9501–F9504	fragments of the funerary bed

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 77%

Soft tissue: large amount of tissue between ribs (SS33), under pelvis (SS34), torso (SS35) and gut area (36)

Sex: female

Age: 36–50 years

Stature: 163.0 ± 1.1cm

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-.
Endocranial changes	.
OA	all sections of the spine and all major joint complexes
IVD	cervical, upper thoracic and lumbar vertebrae
Trauma	healed fracture on the left iliac blade (see Figure III.132) and vertebral ends of two left and one right middle rib fracture of the left humerus (proximal third, Figure III.130) healing fractures on the sternum and sternal ends of two left middle ribs
Dental pathologies	calculus and periodontal disease DEH
Other pathologies	calcified plaques associated with the iliac artery (see Plates 30.5, 30.6)

Dental status

R	-	-	-	-	-	-	-	-	-	-	-	-	P4	-	-	M3	L
	x	x	x	P4	P3	C	-	I1	I1	-	-	-	-	-	-	-	

G238

Orientation: E–W, niche: south
Number of burials: 1

Superstructure:

Dimensions: N–S: 5.0m, E–W: 5.6m
Description:

The superstructure [9188] of the grave consists of a low circular mound of alluvial silt covered with a loose scatter of small to medium-sized (<30cm) schist stones (see Figure III.22). The schist scatter is mainly on south, east and west side, very few were found on the south side where the mound slopes considerably towards the south east.

Shaft:

Dimensions: 2.40m EW x 0.90m NS, depth: 1.40m
Description:

The large shaft of the tomb [9186] is rectangular with vertical walls and slightly rounded edges cut into the alluvial silt. The cut walls are rather friable and therefore likely not to represent the original outline of the shaft. The shaft was backfilled with windblown sand [9187] which except for some sherds was void of finds.

Seven large schist slabs and several large fragments of mud plaster (all [9192]) presumably represent remnants of a destroyed niche blocking structure. Except one, the schist slabs were found leaning orderly against the southern wall resting on the bench on the bottom of the shaft and niche. Fragments of the plaster bear imprints of woven basketry or mat.

Niche:

Dimensions: 2.50m EW x 0.80m NS, height: 0.40m
Description:

Spacious, oval shaped burial niche [9193], cut into the alluvial silt on the southern side of the shaft. The floor of the niche is 0.30m lower respect to floor of the shaft. The ceiling is not entirely intact anymore due to the instability of the alluvial silt. The side walls display parallel chisel marks. The upper part of the niche was filled with sterile, windblown sand [9194] covering two thirds of the niche's original height. The lower part of the niche is filled with deposit [9198], consisting of silt rubble and windblown sand (<20%). The burial within the niche was completely disturbed and heavily fragmented. A large amount of wooden fragments from a coffin or burial bed were also mixed within the deposit which filled half of the chamber's height. Running all along the south wall are imprints of wood as well as painted plaster (F9533) still adhering to wall with painted side facing the wall, attesting to the presence of a decorated bed or coffin (see Figure III.65).

Ceramics

[9198]	one red-burnished bowl (only fragments)

		one marl-clay vessel (only fragments)
Finds		
[9198]	F9500	three tail bones of a large ungulate (l: 3.6cm, w: 1.2cm, t: 0.8cm)
	F9503	ivory fragments from an unidentified object (largest piece: l: 5.8cm, w: 2.7cm, t: 0.9cm)
	F9522	wooden fragments from coffin or funerary bed
	F9523, F9535	fragments of painted plaster with yellow and black paint, (largest fragment 3.6 x 2 x 1.6 cm)

Sk238/ [9198]

Funerary ritual

Body Orientation: -

Body Position: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 42%

Sex: male

Age: old adult

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	bilateral striations on both tibiae on the medial side of the shaft, corresponding NBF on the left fibula
Sinusitis	extensive NBF in both maxillary sinuses
Ribs	strong NBF on the visceral side of four right and seven left ribs concentrating in the angle
Endocranial changes	-
OA	right temporal and ACJ, both shoulders including impingement, right elbow and wrist, both hands and hips
IVD	-
Trauma	fracture one the shaft of one left middle rib
Dental pathologies	abscess on urI2, lrI1, llM1, llM2 strong calculus
Other pathologies	complete fusion (except C4/C5) of the spine involving neural arches and spinal processes (see Figures III.107, III.108)

Dental Status

R	-	-	-	-	-	x	x	x	-	-	-	-	-	-	-	-	L
	x	x	x	/	P3	C	/	x	I1	x	x	x	x	x	x	x	

G239

Orientation: E–W, niche: south
Number of burials: 3

Superstructure:

Dimensions: N–S: 5.0m, E–W: 5.6m
Description:
The superstructure [9258] consisted of a low circular mound of alluvial silt, covered with a scatter of schist plates (<30cm, see Figure III.22).

Shaft:

Dimensions: 2.00m EW x 0.75m NS, depth 1.40m
Description:
The cut of the shaft [9256] is rectangular to oval shaped cut with vertical side walls cut into the alluvial silt. The southern side of the rim is not intact anymore: about 15cm had already collapsed due to the friable alluvial silt in which is it cut into. The backfill [9257] consists of windblown sand, filling the shaft until 1.20m. Due to disturbance of the burial, several sherds and a small number of disarticulated human remains were present in the shaft. The bottom 20cm of the shaft is filled with a deposit of denser debris of sherds and fragmentary human remains from the disturbed burials in the niche as well as mud plaster fragments deriving covering structure [9259]. No clear differentiation could be made between this deposit and the fill of the niche. It fills the bottom 20-30cm of the shaft. In addition several schist stone plates, representing elements of the original covering structure were recovered from the bottom of the shaft.

Ceramics

[9256]	C9149	large jar, base only preserved
	C9150	red-burnished bowl
	C9153	pilgrim flask
	fragments of a second red-burnished bowl, one Nubian vessel, a second jar	
[9259]	C9151	bowl with red-painted rim
	C9152	bowl with red-painted rim
	rims of two more vessels	

Niche:

Dimensions: 1.85m EW x 0.75m NS, height: 0.30m
Description:
The low, rectangular burial niche [9260] is carved into the alluvial silt on the southern side of the shaft. It has vertical walls; the ceiling is only partially intact. The niche is filled to the top by disturbed deposit [9261] consisting of silt rubble and windblown sand (<30%). On the western side of the niche, three large schist plates (<40cm) belonging to the original blocking structure were scattered within

the fill. The deposit holds fragments of human remains as well as sherds from at least four bowls and one jar (see Figure III.67).

The three burials and accompanying grave goods (see Figure III.68) within the niche were partially disturbed and fragmentary. Of the topmost burial, Sk239-1 the upper body, pelvis and parts of the lower extremity were still intact. Two copper alloy needles (F9507) and (F9509) were found underneath the pelvis. Heavily disintegrated remnants of wood on the northern and southern side of the niche potentially represent remnants of a burial bed (F9508).

Underneath Sk239-1 [9262], disarticulated remains [9263] as well as remnants of two more, heavily fragmented individuals were recovered representing earlier stages of use of the niche. Due to the poor state of preservation, re-assembling of individuals was not possible. On the western side of the niche an articulated torso (right rib-cage and thoracic vertebrae and right radius) of a prone, east-west orientated were recovered (Sk239-2, [9264]). They rest on somewhat congregated, discoloured soil, possibly due to decomposition fluids or deteriorated wood (AS 259). In association with bones, fragments of a textile were found, representing remains of the wrapping of body (F9514, AS258). On the eastern side of the niche, an articulated left arm (humerus, radial head), vertebrae and ribs along north side were recovered potentially several wood fragments (one with possibly rope attached – F9528). Further finds, scattered loosely within the fill include three cowry beads (F9510), a copper alloy hook (F9511).

Ceramics

[9261]	C9149	large jar, base only preserved
	C9150	red-burnished bowl
	C9153	pilgrim flask
	fragments of further four bowls and one jar	
[9163]	C9044	bowl with red-painted rim
	fragments of further bowls and jars	

Finds

[9261]	F9512	wooden fragments (largest fragments 4.4x1.7x0.7cm)
	F9514	fragment of unknown white substance (2.4x1.4x1.0cm)
[9263]	F9510	three cowry shell beads (largest: l: 1.6cm, w: 1.2cm, t: 0.5cm)
	F9511	copper alloy hook (l: 1.9cm, w: 0.9cm, d: 0.5cm)
	F9513	cylindrical artefact in a dense black material (charcoal?), thin lines along the fragmented end (l: 2.2cm, d: 0.8cm)
	F9515	fragments of wood from unidentified objects (largest fragment: 4.3x2.2x1.2cm)
	F9528	fragments of rope, (l: 3.3cm, w: 1.7cm, t: 1.6cm)
	F9534	fragments of textile, (largest fragment: 2.3x0.6x0.3cm)

Burials

<u>Sk239-1/ [9262]</u>

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds:

F9507 copper alloy needle, l: 6.9cm, t: 0.2cm

F9508 fragments of dark wood from undetermined funerary container (largest fragment 5.4x2.0x1.6cm)

F9509 copper alloy needle, (l: 7.9cm, t: 0.3cm)

Skeleton

Articulation: commingled

Bone preservation: 4/4

Completeness: 45%

Soft tissue: soft tissue from thorax area SS39

Sex: female

Age: indifferent

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-.
Endocranial changes	.
OA	left ulna and hand
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk239-2/ [9264]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds:

F9514 textile fragments from wrapping of the burial

Skeleton

Articulation: partially intact

Bone preservation: 4/4

Completeness: 13%

Sex: female

Age: adult

Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic spine
IVD	-
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental Status: no teeth

Sk239-3

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/4
Completeness: -
Sex: male
Age: adult
Biomolecular: C/O-sample AW4
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	lamellar NBF in frontal sinus
Ribs	-
Endocranial changes	patches of NBF in *Sulcus sinus sigmoideus*
OA	-
IVD	-
Trauma	-
Dental pathologies	caries on urM2 periapical lesion on urC
Other pathologies	-

Dental status

R	-	M2	M1	-	-	C	I2	-	-	-	-	-	-	-	-	-	L
	M3	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	

G240

Orientation: E–W, niche south
Number of burials: 1

Superstructure: -
Shaft:

Dimensions: 1.0m NS x 1.90m EW, depth: 1.0m
Description:

Rectangular, east-west orientated grave cut [9265] with vertical side walls cut into the alluvial silt. The shaft is backfilled with a deposit of windblown sand [9266] down to a depth of 1.10m and 1.20m below surface. It holds a small number of sherds and one sherd used as shovel. The bottom of the shaft is filled with dense, 6-10cm thick deposit [9268] of debris of silt and mudbrick rubble from disturbed blocking structure. Within the deposit there are three bread molds (C9045, C9046, C9047), which may have been used within an offering ritual, as well as fragments from at least four other vessels. Bottom of shaft is roughly flat; a burial niche [9270] is cut into its northern wall.

The blocking structure of the niche was largely intact, comprising a large schist slab (1.90 x 0.65 x 0.1m), covering the entire niche. Of the mud plaster sealing the stone to the wall, only remnants were preserved.

Ceramics

[9268]	C9045–C9047	bread molds

Finds

[9268]	F9516	flat fragment of copper alloy (l: 2.2cm, w: 1.0cm, t: 0.2cm)
	F9517	copper alloy fragment (l: 1.6cm, w: 1.3cm, t: 0.2cm)

Niche:

Dimensions: 1.0m NS x 1.90m EW, depth: 1.0m
Description:

The low, roughly rectangular burial niche [9271] was carved into the north side of the shaft. The ceiling is only partially intact. The floor is flat and 0.20cm deeper than the floor of the shaft, creating a stepped profile. The top of the burial niche was filled to the top by a deposit of windblown sand [9272] which entered the niche through gaps in the covering structure and was completely void of finds. The bottom of the niche is filled with deposit [9273] holding the disturbed remnants of one female burial (Sk240), mixed with large chunks of ceiling collapse, silt rubble and sand. Congregated sand on the western side of the deposit indicates water entering the niche which is potentially related to flooding of the wadi, similar to deposits in other lower lying tombs. The finds associated with the skeleton (see Figure III.69) are loosely scattered within the fill and highly fragmentary. However, the skeletal elements are generally in their position to be expected in a west (head) – east orientated burial. Fragments of textile found along the legs of the burial indicate wrapping. On the bottom of the niche remnants of the burial were left in situ [9274]. Left were both forearms with left one crossed gut, three lumbar vertebrae and parts of left pelvis (only *crista iliaca*), ribs and both patellae. The position of the bones indicates an extended, prone burial. Around the forearms pieces of soft tissue and textile were recovered (F9533, BS179). Underlying skeleton is a layer of dark powdery substance presumably matting remains or deteriorated wood.

Sk240/ [9272], [9274]

Funerary ritual

Body Orientation: W–E

Body Position: extended, prone

Associated finds:

F9518	flat fragments of ivory, incised with squares (inlay?), (l: 6.2cm, w: 3.7cm, t: 0.5cm)
F9519	fragments of wood decorated with incised flowers (pigment container?), (l: 3.2cm, w: 2.4cm, t: 1.3)
F9520	fragments of matting or basketry from reed, (largest fragment 4.3x1.3x1.0cm)
F9521	fragments of wood (bed?), (largest fragment: 64x1.5x1.4cm)
F9524	small fragments of textile (largest fragment: 1.4x0.8x0.8cm)
F9525	fragment of yellow ochre, (l: 5.3cm, w: 4.2cm, t: 2.4cm)
F9526	sub-spherical piece of unfired clay, (l: 6.1cm, w: 5.7cm, t: 4.7cm)
F9527	small white pebble, (l: 2.8cm, w: 2.0cm, t: 1.4cm)
F9529	fragment of ivory bead (l: 1.7cm, w: 0.5cm, t: 0.2cm)
F9530	fragment of green pigment (l: 1.3cm)
F9531	small fragments of black pigment (<1.1cm)
F9532	small ivory fragment (l: 1.4cm, w: 0.5cm, t: 0.4cm)
F9533	fragments of textile from wrapping, (largest fragment 1.5x1.0x1.0cm)

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 48%

Sex: female

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions and hypertrophy in both orbital roofs
NBF	remodelled NBF on both fibulae, striations on the medial side of the left tibia
Sinusitis	-
Ribs	-
Endocranial changes	very deep vessel impressions and slight plaque deposition in frontal occipital
OA	both TMJ, right shoulder, both wrists, right hand, both knees, ankles, foot all sections of the spine
IVD	IVD in the lumbar vertebrae
Trauma	healed fracture on sternal end of one right rib
Dental pathologies	-
Other pathologies	-

Dental status

R	-	-	-	-	-	-	-	-	/	x	x	x	x	x	x	x	L
	M3	M2	M1	P4	x	C	I2	I1	I1	I2	C	P3	P4	M1	x	x	

G241

Orientation: E–W, niche: north
Number of burials: 2

Superstructure:

Dimensions: d: 8.70m
Description:

The superstructure [8350] consists of a low mound of silt rubble marked with a scatter of schist plates (see Figure III.22). The grave is part of a group with no clear demarcation between the superstructures. Mixed within the windblown sand partially covering the tumulus were some sherds and disarticulated human bones.

Shaft:

Dimensions: 1.0m NS x 1.90m EW, depth: 1.0m
Description:

The shaft was backfilled with a deposit of windblown yellow sand [8351] which holds a small amount of disarticulated, fragmentary human skeletal elements and sherds. As the niche was partially opened, the windblown sand extended into the upper part of the burial niche with no clear distinction between the two layers.

Of the blocking structure of the niche [9354], consisting of a row of substantial schist plates, only the eastern part remained intact, comprising two large plates superimposed in the centre of the niche (larger one 102x70cm) as well as several smaller ones on the eastern side, sealed together with mud plaster. A shovel sherd was recovered from among the mud plaster.

Ceramics

[9354]	F7192	one large body sherd used as a shovel

Niche:

Dimensions: 2.05m EW x 1.0m NS, height: 0.48m

Descriptions:

The narrow, rectangular burial niche was carved into the north side of the shaft, situated 0.50m lower than the bottom of the shaft creating a step-like profile [9358]. The walls and floor where straight, with chisel marks on all sides. The niche was filled entirely with a loose deposit of yellow windblown sand mixed with some alluvial silt rubble [9356]. The two burials within the niche were completely disarticulated and scattered within the fill. In addition, the fill held strands of hair, wooden fragments and some textile fragments (F9601).

Finds

[9356]	F9600	small spherical bead in green stone
	F9601	fragment of a rope

Burials

Sk241-1/ [9356]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/1

Completeness: 15%

Soft tissue: hair SS46 and brain tissue SS47

Sex: indifferent

Age: 36–50years

Stature: 168.9 ± 1.4cm

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-

IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

<u>Sk241-2/ [9356]</u>

Funerary ritual

Body Orientation: -
Body Position: -
Associated finds: -

Skeleton

Articulation: disarticulated
Bone preservation: 5/1
Completeness: 37%
Sex: male?
Age: 15–20 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	woven on left iliac blade dorsal and ventral, right ventral only
Sinusitis	n/a
Ribs	woven NBF on six ribs left and five ribs right ventral
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH caries mild calculus
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	M3	M2	/	P4	P3	C	/	I1	I1	I2	C	P3	/	M1	M2	M3	

G242

Orientation: E–W, niche north
Number of burials: 1

Superstructure:

Dimensions: d: 8.0m
Description:

The superstructure [9359] comprises a circle of black schist stones (max. 30cm, see Figure III.22). Due to its proximity to superstructure of G241, demarcation is not clear. Some scattered sherds and human remains were found between the stones, indicating looting of the tomb.

Shaft:

Dimensions: 2.20m EW x 0.60m NS, depth: 1.0m
Description:

The shaft of the grave was rectangular to oval shaped, carved vertically into the alluvial silt (cut [9360]). The walls are somewhat friable, displaying parallel chisel marks. The shaft was backfilled with windblown yellow sand [9361], containing a small amount of disarticulated skeletal human remains. The eastern part (0.50m EW) of the shaft is filled with a darker deposit of silt rubble [9362], possibly representing the original backfill of the niche. The blocking structure of the niche [9363] was intact in the eastern half of the grave (l: 0.70m EW), comprising a row of diagonally placed schist slabs sealed with mud plaster.

Niche:

Dimensions: 2.20m EW x 0.50m NS, height: 0.40m
Description:

The burial niche (cut [9367]) was rectangular, with a rounded ceiling and flat floor situated 0.68m lower than the bottom of the shaft. The burial niche was also backfilled with windblown yellow sand [9364] and completely disturbed. The single burial [9365] within the chamber was entirely disarticulated, with bones scattered loosely in the windblown sand. Parts of the skeleton including the skull were missing.

<u>Sk242</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 6/2
Completeness: 50%
Sex: male?

Age: 20–30 years
Stature: 163.8 ± 1.1cm
Pathologies:

Orbital lesions	n/a
NBF	remodelled changes on both tibiae and fibulae along entire shaft remodelled NBF in mandibular ramus
Sinusitis	n/a
Ribs	remodelled changes on four middle right and three middle left ribs
Endocranial changes	-
OA	thoracic spine right foot
IVD	-
Trauma	-
Dental pathologies	DEH mild calculus and periodontal disease
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- L
	M3	M2	M1	/	/	/	/	/	/	/	/	/	/	M1	M2	M3

Sk245

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 11%
Sex: indifferent
Age: adult
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	remodelled changes both tibiae proximal and distal on the medial side of the shaft
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a

OA	both knees
IVD	n/a
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

G246

Orientation: E–W, niche: north
Number of burials: 5

Superstructure:

Dimensions: d: 9.0m
Description:

The superstructure of the tomb [9368] comprises a sub-circular mounds covered with schist stones (see Figure III.22). Some scattered sherds and human remains [9369] attest to looting of the tomb.

Shaft:

Dimensions: 2.20m EW x 1.0m NS, depth: 1.0m
Description:

As in the other graves, the shaft was rectangular and vertically carved into the alluvial silt (the bottom of the shaft is flat). A rectangular, burial niche is carved into the northern side of the shaft, starting at a depth of 0.65m below present surface level and situated only 0.15m lower. The shaft was entirely backfilled with windblown yellow sand [9370]; holding disarticulated human remains, sherds and wooden fragments. No remnants of a blocking structure to the niche were recovered in this tomb.

Finds

[9370] F7190 large body sherd used as shovel

Niche:

Dimensions: 1.90m EW x 0.80m NS, height: 0.60m
Description:

The rectangular burial niche was largely backfilled with yellow windblown sand [9371] with no clear distinction between the shaft and niche. The niche held the burials of five individuals, all were entirely disarticulated and loosely scattered within the windblown sand. Preservation of the skeletons was very poor and a large proportion of elements were missing. The bottom of the niche is filled with a denser deposit of disarticulated bones mixed with silt rubble [9373]. A large amount of wooden fragments attests the presence of one or more funerary containers even though its exact nature cannot be clarified. Carved into the flat floor of the niche are two rectangular depressions on the west (77x38cm, depth: 8cm) and east end (82x30cm, depth: 8–9cm) of the niche which can be identified as holes for a funerary bed based on comparison with other sites in Sudan (e.g. Missiminia, Vila, 1980: 106).

Finds

[9371]	F7191	large body sherd used as shovel
	F9605	small, ovoid ivory bead (0.5x0.5cm)
	F9606	three beads: one ovoid ivory (0.5x0.5cm), two cylindrical copper alloy (l: 0.7cm, d: 0.6cm)
	F9607	small amount of wooden fragments from unknown object (max. l: 4.4cm, w: 1.4cm, t: 1.2cm)

Burials

Sk246-1/ [9373]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 17%

Sex: indifferent

Age: 6–10 years

Stature: -

Pathologies:

Orbital lesions	strong porosities and marked hypertrophy
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

Sk246-2/ [9373]

Funerary ritual

Body Orientation: -

Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/4
Completeness: 28%
Sex: female
Age: 3–5 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental Status: no teeth

<u>Sk246-3/ [9373]</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 30%
Sex: female
Age: 21–25 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial	-

changes	
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH caries
Other pathologies	SN in lumbar spine

Dental Status

R	-	-	-	-	-	-	I2	I1	I1	I2	C	P3	-	M1	-	-	L
	-	-	-	-	P3	C	I2	I1	-	I2	C	P3	-	-	-	-	

Sk246-4/ [9373]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 37%

Sex: male?

Age: 20–30 years

Stature: 172, 3 ± 3.3cm

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	left shoulder
IVD	-
Trauma	healed fracture on left distal radius healed fractures on one right proximal and distal phalanx right healed fracture on left zygomatic arch
Dental pathologies	DEH mild calculus
Other pathologies	button osteoma on frontal bone

Dental Status

R	M3	-	-	-	-	-	I2	I1	-	-	-	-	P4	-	-	-	L
	M3	M2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

<u>Sk246-5/ [9373]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 11%

Sex: indifferent

Age: adult

Stature: -

Pathologies:

Orbital lesions	-
NBF	new bone formation on the right tibia and both fibulae (healed)
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine left ACJ and shoulder, both knees
IVD	cervical, thoracic and lumbar spine
Trauma	small depression fracture, healed
Dental pathologies	DEH mild–moderate calculus
Other pathologies	-

Dental Status

R	-	-	-	-	-	-	-	-	<u>I1</u>	-	-	-	-	-	-	-	L
	M3	M2	M1	-	-	-	I2	I1	-	-	-	P3	-	M1	M2	M3	

Cemetery D

New Kingdom tombs

G301

Orientation: E–W, chambers W and NE

Superstructure

Dimensions: chapel: 4.10m EW x 3m NS, height: 0.50m
Description:

Pyramid superstructure built from mud bricks (38x20x8.0–9.0cm) connected with a mortar of mud (see Figure III.4). While the chapel is completely preserved, the pyramid base has largely been destroyed. The walls appear to have been placed directly onto the alluvial surface. The northern and southern walls have a thickness of 60–65cm; the eastern and western walls are only 38-40cm thick. The layout of the bricks is not very regular, with a stretch of vertically placed bricks on the west side of the structure. Due to wind erosion, only three courses remain of the southern wall while only two courses of bricks are preserved on the northern side.

Ceramics

[8006]	C8116	base of jar
[8007]	C8103	plate, red slipped
	C8118	jar, potentially Nubian
	at least six plates, sherds of Nubian vessels, 10 sherds of beer jars	

Shaft:

Dimensions: 2.0m EW x 1.1m NS, depth 2.80m (bottom 0.90m rock-cut)
Description:

The vertical rectangular shaft [8014] in the centre of the chapel was entirely filled with windblown sand [8029]. The bottom of the shaft is flat and even, parallel chisel marks are visible on all sides of the shaft. A large schist stone slab (0.90 x 0.35m), recovered on the western side on the floor may represent sealing structure. The bottom was covered with deposit [8030] of 30cm thickness, consisting of schist gravel, mudbrick pieces and mudplaster from the destroyed entrance blocking of the north-eastern chamber. Shabti (F8005) was found within the deposit near the entrance to the western chamber (see Figure III.31). Other finds within the deposit include sherds of at least two beer jars, a red-slipped plate and a pot stand.

Ceramics

[8006]	C8116	base of jar
[8029]	C8105	bowl
	C8117	large eroded fragment of jar
	eroded sherds from at least three more vessels including one Nubian pot	
[8030]	at least two beer jars, a plate and a pot stand	

Finds

[8030]	F8004	shabti from fired clay, (h: 16.6cm, w: 6.2cm, t: 4.4cm)

North-Eastern chamber:

Dimensions: 2.0m EW x 2.10m NS, height: 1.0m at the entrance, 0.70m at the back.
Number of burials: 6
Description:

The square burial chamber is carved into the bedrock (cut [8037]) with vertical walls, straight ceiling and flat floor sloping towards the northern end of the chamber. The narrow, rectangular entrance was originally blocked by a schist slab ([8036], 154x34x12cm) and mudplaster sealing the gaps. While the mudplaster was largely removed through looting activity, the schist slab remained in place. The chamber was partially backfilled with a 30cm thick deposit of yellow wind-blown sand [8031] mixed with some mudbrick fragments and pieces of ceiling collapse. It further holds sherds from at least one plate and one beer jar.

Right behind the entrance to the north-eastern chamber two burials, both of juvenile individuals Sk301-1/ [8061] and Sk301-2 [8062] were found placed on top of each other. Both individuals were buried in an extended position, tightly wrapped and placed in fragmentary doum palm coffins. The skeletons were disturbed below the knee suggesting that they were not found in their original burial position. The back of the chamber is filled with a deposit [8085] of loose yellow windblown covering the disarticulated human remains of at least four more individuals piled up against the back wall. They presumably represent an earlier phase of use of the chamber and were removed in order to create space for the consecutive burials. A large number of wooden fragments and pieces of plaster with yellow and red paint indicate the presence of one or more coffins. Ceramics are confined to several eroded sherds.

The number of finds recovered from the fill of the north-eastern chamber was relatively small (see Figure III.53). A large number of beads made of carnelian, faience, ivory and red jasper, three *udjet*-eyes in faience and carnelian, three small cat-shaped amulets representing parts of one or several necklaces were recovered from the windblown sand deposit [8063] underlying the skeletons Sk301-1 and Sk301-2 in the entrance area. While some of them were found in alignment, suggestive of a composite necklace the majority were found loosely distributed within the fill. Fragments of wood decorated with painted plaster were also recovered from the fill, even though establishing an association with either of the burial phases remains difficult. The amount of pottery from the chamber is very small and confined to a few heavily eroded sherds.

Ceramics

[8031]	C8002	jar with thick red slip
[8031], [8085]	C8119	plate

Finds

[8031]	F8005	four ovoid cornelian beads (max. d: 0.35cm), one bone cylinder bead (d: 0.25cm), one faience disc bead (d: 0.2cm, t: 0.2cm)

	F8030	fragments of plaster (some with red and black paint, max 7.5x3.0x2.5cm), coffin
	F8033	small fragments of brown wood (<1.8cm)
	F8034	ovoid bone bead (l: 1.2cm, d: 0.8cm)
[8063]	F8010	remnants of one or several necklaces with three cornelian *udjat*-eye amulets, three amulets of cats or crouching calves in carnelian and porphyry as well as a large number of carnelian beads
	F8014	red carnelian *udjat*-eye amulet (h: 0.9cm, w: 1.2cm, t: 0.3cm)
	F8036	two small fragments of white plaster with remnants of yellow and red plaster
	F8037	small ovoid (bone, d: 0.5cm), cylindrical (d: 0.35cm, l: 0.55cm) and spherical (d: 0.35cm) beads in cornelian
[8069]	F8025	ovoid cornelian bead, (d: 0.4cm)
	F8026	fragment of worked ivory, l: 1.4cm, h: 0.6cm, t: 0.3cm
	F8087	fragments of white plaster (largest fragment 2.6x1.6cm)
[8084]	F8057	fragments of white plaster (max. 4.4x3.2x1.4cm)
	F8058	small ovoid cornelian bed, (d: 0.3cm)
	F8059	fragments of very small powdery wood from coffin or burial bed (max. 1.4x1.4x0.7cm)
[8085]	F8022	scarab in steatite with green-blue glaze, four uraei with sun disc above head (l: 1.5cm, w: 1.1cm, t: 0.7cm)
	F8046	remnants of unspecified dark wooden object (max. 4.7x3.5cm, t: 1.2cm)
	F8050	irregular piece of green-grey schist, coffin stand?
	F8051	jewellery including three penannular earrings in red cornelian (one with incised edge, (d: 1.9cm, t: 0.7cm), two with polished edges (d: 1.6cm, t: 0.6cm; d: 1.2cm, t: 0.4cm), 15 ovoid beads (d: 0.3cm), one flat ovoid bead (l: 1.7cm, w: 0.9cm)
	F8052	remnants of a dark wooden object (max: 4.3x2.4x1.4cm)
	F8053	large number of white plaster fragments, some with red and black paint (max: 2.0x6.6cm)
	F8084	very degraded wooden fragments (max 2.5x1.2x0.4cm)
	F8055	fragments of dark brown wood (max. l: 4.0cm, w: 1.5cm, t: 0.8cm), perhaps head-rest
	F8056	fragments of dark brown wood (max. 3.9x1.2x1.5cm)
[8094]	F8031, F8032	small fragments of white plaster with yellow and red paint (max: 2.2x1.0x0.9cm)

Burials

<u>Sk301-1/ [8061]</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, prone

Associated finds:

F8006	fragment of small faience *udjet*-eye amulet (h: 0.8cm, w: 0.9cm, t: 0.3cm)
F8007	small, cornelian amulet of a seated cat (l: 0.9cm, h: 0.9cm, t: 0.4cm)
AS63	doum palm wrapping

Skeleton

Articulation: complete

Bone preservation: 2/4

Completeness: 32%

Sex: indifferent

Age: 12–15 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	slight calculus DEH
Other pathologies	-

Dental status

R	-	M2	M1	-	P3	C	I2	I1	I1	/	/	P3	P4	M1	M2	-	L
	-	M2	M1	P4	-	-	/	I1	I1	/	/	P3	P4	M1	M2	M3	

Sk301-2/ [8062]

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds:

F8013 fragments of a doum palm coffin

F8019 six ovoid cornelian beads (d: 0.3cm, t: 0.3–0.5cm)

F8028 fragments of a doum palm coffin

Skeleton

Articulation: disarticulated

Bone preservation: 3/4

Completeness: 42%

Sex: indifferent

Age: 12–18 years

Biomolecular: C/O-sample AW12
Pathologies:

Orbital lesions	porosities in both orbital roofs
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	n/a
Trauma	-
Dental pathologies	slight calculus DEH
Other pathologies	-

Dental status

R	-	-	-	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk301-5/ [8085]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 29%
Sex: female
Age: 36–50 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	both knees thoracic and lumbar spine
IVD	thoracic spine
Trauma	-

Dental pathologies	-
Other	-

Dental status

R M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk301-6/ [8085]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3

Completeness: 23%

Sex: indifferent

Age: 18–25 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

Sk301-7/ [8085]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4
Completeness: 15%
Sex: indifferent
Age: 12–15 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status

R	-	M2	M1	P4	P3	-	-	-	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Western chamber

Dimensions: 3.20m EW x 2.70m NS, original height: 0.80m
Number of burials: 2
Description:

The rectangular doorway of the western chamber was blocked by a mudbrick wall [8039] which seemed largely intact upon excavation. The round burial chamber [8040] has straight walls and a flat bottom which are well carved into the schist bedrock. Few parallel chisel marks are visible in parts of the wall. The chamber was filled with a dense deposit of 0.65m of collapsed ceiling ([8071], schist gravel and alluvial deposits) presumably caused by attempts to loot the burial through a narrow tunnel [8017] dug from the surface. Intact parts of the ceiling along the western and southern side of the chamber indicate that the ceiling was originally flat as well.

The ceiling collapse preserved the content of the burial chamber [8083] intact. Seven intact vessels were deposited against the northern wall of the chamber (see Figure III.29). The chamber was originally not backfilled. In the western half of the chamber, two extended, N-S-orientated burials of a male and a female were deposited side by the side. Both of them were buried in wooden coffins decorated with plaster painted in red, black and yellow, which are very fragmented due to the collapsed ceiling. The coffin of the male individual to the west was apparently toppled up on two large schist stones. Small fragments of textiles adhering to both skeletons indicate that the individuals were mummified in some way.

Ceramics

[8083]	C8004–C8008	beer jars
	C8003, C8010, C8011	plates
	C8009	amphora (hieratic inscription *"year 10, wine of 3 days (fermentation) of the vineyard of Hormes"*

Finds

[8083]	F8023	scarab (Ramesses II) (see Figure III.31)
	F8024	bronze knife
	F8029,	small, very powdery fragments of white plaster (max. 3.5x2.0x2.0cm) and wood (1.4x0.8x0.6cm) representing remnants of coffin
	F8035	skeleton of a neonate piglet
	F8038	small fragment of unidentified bone with one surface worked (l: 2.5cm, w: 0.9cm, t: 0.6cm)
	F8062	fragments of plaster with red and black paint from coffin (max. 8.3x6.3x2.0cm)

Burials

Sk301-3/ [8083]

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

AS112 textile fragments from wrapping

Skeleton

Articulation: articulated

Bone preservation: 2/4

Completeness: 38%

Sex: female

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions in both orbital roofs
NBF	-
Sinusitis	NBF in frontal sinus
Ribs	-
Endocranial changes	HFI
OA	TMJ, right wrist, both knees and ankles cervical and thoracic spine

IVD	lower thoracic spine
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status

R	-	<u>M2</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	<u>M3</u>	-	-	-	-	x	I2	I1	x	R	R	R	R	R	R	x	

<u>Sk301-4/ [8083]</u>

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8063 remnants of wooden coffin, largest fragment<1.5cm

AS128 textile fragments from wrapping

Skeleton

Articulation: disarticulated

Bone preservation: 3/3

Completeness: 54%

Sex: male

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions in roof
NBF	healed NBF in right and left tibia distal
Sinusitis	healed NBF in both maxillary and sphenoid sinuses
Ribs	visceral on five left and right ribs
Endocranial changes	-
OA	all spine
IVD	-
Trauma	well healed fractures on two left middle ribs
Dental pathologies	AMTL periapical lesions on urC, ulI^1, ulI^2
Other pathologies	probable DISH (see Figure III.110)

Dental status

R	/	x	/	/	/	C	/	/	x	x	C	P3	P4	M1	/	M3	L

x	x	/	/	/	/	/	/	/	/	/	/	/	x	/	/

G309

Orientation: E–W, burial chambers E and W

Superstructure:

Dimensions: chapel: 4.70m EW x 3.5m NS, height: 0.50m, pyramid base: 1.20m EW x 1.0m NS, height: 0.05 – 0.15m
Description: The superstructure comprises an east–west aligned chapel [8122] built from mud bricks (31–35x16x10cm) bounded with mud plaster. The walls reach a thickness of 0.60m. The southern side is preserved to a height of three courses of bricks, while the northern side has been deflated to only the bottom row of bricks. The exterior side of the southern wall shows traces of mud plaster [8133]. Adjoining to the possible chapel remains [8122] from the west. On the western side of the chapel is a small east–west aligned pyramid base [8123] built from mud bricks of similar size to the chapel bounded with mud mortar but reduced to only one course of bricks. The base is not a solid platform but a rectangular outline with dark, fine loose silty material [8119] in the centre. Some bricks along the exterior side show a certain degree of tapering. Both parts of the superstructure were built onto the alluvial silt, on the southern side a foundation trench ([8139], w: 5cm) is visible.

Shaft:

Dimensions: 1.80m EW x 1.05m NS, depth: 2.10m
Description: Entrance to the substructure of the tomb is provided by a vertical, rectangular, east–west aligned shaft [8135]. The bottom 0.80–1m is carved into the schist bedrock. The upper parts of the shaft were carved into the alluvial silt. Between a depth of 0.80m and 1.20m below surface the walls were decorated with mud plaster. Additionally, a wall of three rows of mud bricks was built into the wall as a support. The shaft was backfilled by yellow, windblown sand until a depth of ... meter. Recovery of a modern iron axe-head (F8000) suggests recent disturbance. The deposit further holds several sherds including two large body sherds potentially used as shovels (C8107, C8018), a small amount of fragmentary human remains and two almost complete vessels (C8014, C8017). In a depth of 1.80m, the shaft is filled by dense deposit [8145] of mudbrick fragments and mud rubble from side walls and blocking structures mixed with windblown sand, containing a small amount of sherds, coffin fragments and disarticulated human remains including the disarticulated legs of underlying Sk309-4 [8146] on the eastern side of the shaft. Underlying the debris layer is the extended W–E burial of a young female individual Sk309-4 with an unborn foetus Sk309-3, buried in a doum palm coffin and adorned with a necklace, two bracelets, and a scarab. It remains unclear whether the burial was originally made in the shaft or relocated from one of the chambers. The burial was truncated in the lower leg area by a semi-circular cut [8148] during looting of the western chamber. The cut is filled with a dense, dark deposit of debris of re-deposited compact, plaster. The individual rests on another dark, compacted deposit [8152] containing mud rubble and mud brick fragments from collapsed walls, blocking or ceiling of the chapel. A small number of human remains were found within the deposit; further indicating that disturbance of burial chambers had already

occurred at a very early stage. A complete beer jar (C8016) was found in front of the entrance to the western burial chamber.

Ceramics		
[8145]	C8018	body sherd of pilgrim flask
[8147]	C8015	plate with red-painted rim
	C8132	red-painted plate, rim sherd only
[8152]	C8016	beer jar
Finds		
[8119]	F8090	iron axe head, modern, (l: 8.7cm, w: 4.1cm, t: 4.1cm)
[8145]	F8098	fragments of a wooden artefact (max. 3.1x1.2x1.0cm)
	F8099	small fragments of plaster from coffin (max. 3.2x2.5x0.8cm)
[8147]	F8196	body sherd used as shovel

Burials

<u>Sk309-3/ [8146]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: articulated, recovered intra-uterine associated with Sk309-4

Bone preservation: 5/2

Completeness: 72%

Sex: indifferent

Age: 6–7lm

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no status

Sk309-4/ [8146]

Funerary ritual

Body Orientation: W–E

Body Position: extended, prone

Associated finds:

F8091, F8092	bracelets consisting of a large number of spherical faience beads (d: 0.4–0.6cm)
F8093	scarab in ivory depicting two baboons with uprising arms towards an obelisk standing between them (l: 1.5cm, w: 1.2cm, h: 0.7cm)
F8094	small cylindrical cornelian bead (d: 0.4x0.3cm)
F8095	two blue and white pendant with 2 holes (one in the pendant and one in the loop, (1.4x0.9x0.5cm) and two spherical white beads (d: 0.5, 0.7cm)
F8096	doum palm coffin, very fragmentary
F8097	small spherical bead in faience (d: 0.5cm)

Skeleton

Articulation: articulated

Bone preservation: 4/4

Completeness: 50%

Sex: female

Age: 21–35 years

Stature: 156.1 ± 2.5cm

Pathologies:

Orbital lesions	strong hypertrophy in the right orbital roof
NBF	parietals and occipital
Sinusitis	n/a
Ribs	healed NBF dorsal on three left ribs, visceral on one left middle rib
Endocranial changes	granular impressions in frontal on right side
OA	thoracic spine
IVD	lumbar spine
Trauma	fracture of a right distal phalanx of the hand
Dental pathologies	slight dental calculus caries DEH
Other pathologies	-

Dental status

R	<u>M3</u>	M2	<u>M1</u>	P4	P3	C	I2	I1	I1	I2	C	/	P4	M1	M2	M3	L
	M3	M2	M1	P4	/	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Western chamber:

Dimensions:
Number of burials: 2 original, 2 intrusive
Description:

The western chamber is accessible through a rectangular doorway; the top of the doorway had been destroyed in connection to the robber tunnel from the surface and subsequent ceiling collapse. However, remnants of mud bricks on the southern side of the doorway indicated it had a mud brick lintel. Further large mud-brick fragments related to the doorway were recovered as debris within doorway and entrance to the chamber [8040] On the southern side, the doorway is lined by a smoothed, rectangular schist stone door jamb [8142] (h: 98cm, w: 32cm, t: 8–9cm), the western wall in the vicinity to the jamb is covered by mud plaster.

In the entrance area of the chamber with the head partially in the doorway, the extended burial of a middle adult male Sk309-2 [8132], resting on the collapsed doorway [8040] and collapsed ceiling of the chamber [8125] was recovered, indicating the grave was still in use for burial after collapse of the chamber. Sk309-2 was covered by yellow windblown sand deposit [8119]. [8125] represents the collapsed ceiling consisting of schist rubble stratum and alluvial silt layer and fills almost the entire chamber.

This deposit overlies the original content of the chamber consisting of two S–N aligned burials in wooden coffins, Sk309-5/ [8159] in the centre of the chamber and Sk309-7/ [8168] against the western chamber. The coffin (F8100 [8137]) and skeletal elements of Sk309-5 are heavily fragmented and in a very poor state of preservation. Sk309-5 was buried in extended supine position, with both arms crossed over the gut area. Position of the bones suggests wrapping even though no traces of textile were preserved. Parts of (F8100) were consolidated; the white plaster shows few traces of yellow, blue, black and red paint but without any clear patterns. The shape of the coffin was not possible to reconstruct fully but may have been anthropoid.

Coffin (F8110 [8163]) of the second burial Sk309-7 (young adult female) was better preserved with the coffin mask intact (see Figure III.33). The wooden coffin is of anthropoid shape, decorated with plaster painted in red, black and blue on a yellow background. The interior seems to have been decorated with plaster too even though no clear traces of paint survived. The coffin was backfilled with windblown sand in the head area and schist/rubble silt [8169]. Associated with skeleton were two cornelian ear-rings (F8443, F8444) with serrated edges and a bronze mirror (F8448) placed underneath the feet (Figure III.32). Small remnants of textile as well as the position of the bones indicate wrapping for burial. The individual was buried extended and prone with arms crossed over pelvis area.

Between the two coffin burials, a third, N–S aligned individual Sk309-6 ([8162] young adult female) buried in an undecorated doum palm coffin was found. Its funerary container suggests a later intrusion even though similar to the other two burials it underlies the ceiling collapse. The individual was buried with a scarab (F8111) placed in the hands.

Underlying burials Sk309-6 and partially Sk309-7 is another deposit [8165] of schist gravel and dark alluvial silt of 30–40cm thickness underneath Sk309-6, filling the chamber until the floor level. This may indicated two distinctive phases of ceiling collapse. Sk309-7 partially rests directly on the cut floor as well as on two large schist slabs used as coffin stands. Ceiling collapse [8165] would have entered the created gap later, thus is still stratigraphically younger. The deposit is void of finds. Along the northern side wall of the chamber four intact vessels (see Figure III.36)were found resting on the cut floor and presumably representing part of the original chamber inventory, a fifth was found partially underneath the coffin (F8110).

Finds

[8165]	F8452	heavily eroded substance, pigment?

Ceramics

[8165]	C8024	shallow plate with red rim
	C8025	plate with red rim
	C8026	jar with straight neck
	C8027, C8028	beer jar

Sk309-2/ [8132]

Funerary ritual

Body Orientation: SE–NW

Body Position: extended, on the left side

Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 43%

Sex: male?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	right ischium, left ilium
Sinusitis	n/a
Ribs	-
Endocranial changes	NBF in *sulcus sinus sagittalis* and in the area of *protuberantia occipitalis interna* meningeoma on parietal right towards coronal suture and parietals left increased vessel activity in both parietals with small impressions
OA	cervical, thoracic and lumbar spine

IVD	lumbar spine
Trauma	small depression fracture on the right parietal
Dental pathologies	severe calculus and periodontal disease abscess on ulC draining into the nasal sinus
Other pathologies	-

Dental status

R -	-	-	-	-	-	x	x	x	x	x	-	-	-	-	-	L
x	x	x	x	P3	/	I2	I1	I1	I2	/	/	/	/	/	x	

<u>Sk309-5/ [8159]</u>

Funerary ritual

Body Orientation: S–N

Body Position: extended, supine

Associated finds:

F8109	small fragments of wrapping
F8100	wooden coffin decorated with painted plaster, partially consolidated
F8115, F8116	fragments of F8100

Skeleton

Articulation: articulated

Bone preservation: 3/4

Completeness: 43%

Sex: female?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	NBF in the orbital roofs
NBF	-
Sinusitis	healed NBF
Ribs	-
Endocranial changes	-
OA	cervical spine
IVD	cervical spine
Trauma	vertebral body fracture C5 and C6
Dental pathologies	AMTL
Other pathologies	healed NBF in right and left mastoid process

Dental status

R	-	-	-	-	x	x	/	/	/	/	/	x	x	x	x	/	L
	x	x	x	x	x	x	x	I1	I1	x	C	P3	x	x	x	x	

Sk309-6/ [8162]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8111 scarab in green steatite, decorated with a sistrum and cow head (l: 1.7cm, w: 1.3cm, t: 0.8cm)

F8456 doum palm coffin, very fragmentary

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 74%

Sex: female

Age: 21–36 years

Biomolecular: C/O-sample AW7

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	small granular impression on skull base
OA	thoracic spine
IVD	-
Trauma	-
Dental pathologies	slight calculus and periodontal disease
Other pathologies	-

Dental status

R	M3	M2	/	/	/	C	I2	I1	I1	I2	/	/	/	/	/	M3	L
	M3	M2	M1	/	/	C	I2	I1	I1	I2	/	/	/	/	/	/	

Sk309-7/ [9168]

Funerary ritual

Body Orientation: S–N

Body Position: extended, prone

Associated finds:

F8110	anthropoid wooden coffin decorated with painted plaster
F8443, F8444	finely carved cornelian ear-ring with serrated edge and fine line carved alongside the edge (d: 1.8cm, t: 0.6cm)
F8448	plain mirror in copper alloy, (l: 25.8cm, w: 15.8cm, t: 0.4cm)

Skeleton

Articulation: articulated

Bone preservation: 4/4

Completeness: 73%

Soft tissue: brain tissue SS47, soft tissue around tarsals SS45

Sex: female?

Age: 21–35 years

Biomolecular: C/O-sample AW5

Pathologies:

Orbital lesions	n/a
NBF	healed, right tibia
Sinusitis	n/a
Ribs	two left middle ribs, healed
Endocranial changes	HFI
OA	thoracic spine right ACJ and wrist
IVD	cervical and thoracic spine
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

Eastern chamber

Dimensions: 1.75m EW x 2.20m NS, height: 0.90m

Number of burials: 5

Description:

The small burial chamber is entirely carved into the bedrock (cut [8139]). It is accessible through a narrow, oval doorway (h: 0.85, w: 0.90m). The door was originally blocked by schist slabs (40–80cm) and mud plaster [8156], some of which were recovered from the fill within the chamber. The chamber is roughly cut with uneven walls, floor and ceiling and possibly represents a later addition. The content of the chamber was completely disturbed through recent looting, indicated through a cigarette bud recovered from within the chamber. The fill of the chamber (d: 0.60cm) of the chambers comprises a loose deposit of yellow, windblown sand [8155] with heavily fragmented disarticulated remains of at least

5 burials, remnants of at least one funerary bed, finds and sherds of several vessels loosely scattered within.

Ceramics

[8155]	C8019	pilgrim flask with red concentric circles and floral decoration
	C8020	red slipped jar
	C8021	handmade bowl with red-painted rim
	C8022	red-slipped bowl
	C8023	pilgrim flask with black concentric lines

Finds

[8155]	F8101, F8113	large amount of small wooden fragments belonging to a funerary bed or other wooden objects (max. 3.5x2.6x2.0cm)
	F8102, F8104	small fragments of white plaster with red and black pigment (max. 4.9x2.5x1.3cm)
	F8105	worked wooden elements from funerary bed(s), (max: 5.8x3.5x2.0cm)

Sk309-11

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness:

Sex: female?

Age: 0–0.5 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

G319

Orientation: E–W, burial chamber W
Number of burials: 4

Superstructure: -
Shaft:

Dimensions: 3.30m EW x 0.90m NS, depth: 1.70m
Description:

Entrance to the chamber is provided by a narrow, rectangular, E–W aligned shaft. While the top of the shaft (cut [9264]) is carved into alluvial silt, the lower 0.90m are carved into the schist bedrock. On the west side of the shaft, the entrance to a burial chamber (h: 1.20m) is located on the bottom. Its original blocking structure [8366], comprising several big schist slabs (max. 130x28x10cm) had been removed entirely and moved into the centre of the shaft. Traces of mud plaster on the slabs and wall of the shaft indicate that the gaps would have been sealed. The eastern wall of the shaft displays traces of initial attempts to carve a second chamber [9367] which were abandoned after 0.30m. The shaft was entirely backfilled with yellow windblown sand [8363]/ [8365].

Ceramics		
	C8142	
Finds		
[8363]	F8361	small fragments of wood from unspecified object (max. 2.0x1.6x0.6cm)
	F8362	fragment of ostrich eggshell (l: 0.8cm, w: 0.7cm, t: 0.2cm)
	F8363	large amount of fragments of plaster originally attached to a wooden artefact (max. 8.8x5.4x2.1cm)
[8365]	F8364	fragments of white plaster, one with traces of yellow and red paint (l: 2.4cm, w: 1.9cm, t: 1.2cm)

Western chamber:

Dimensions: 2.20m EW x 1.75m NS, depth: 1.70m
Number of burials: 4
Description:

Ceramics		
[8368]	C8084	beer jar
Finds		
[8368]	F8365	scarab in steatite, originally glazed green, bearing cartouche of Ramesses II (l: 2.1cm, w: 1.6cm, t: 0.9cm)
	F8366	fragments of plaster, originally covering wood impressions, some with traces of yellow, red and black paint
	F8367	fragments of wood (max. 3.9x1.4x0.6cm)
[8369]	F8368	fragments of plaster, originally covering wood impressions, some with traces of yellow, red and black paint (max. 6.9x2.1x1.2cm)
	F8369	fragments of an upper part of a head-rest (l: 4.3cm, h: 2.5cm, w:

	2.2cm)
F8370	small fragments of reed (max. 3.2x1.4x.0.5cm)
F8371	fragments of wood (max. 2.9x1.1x0.8cm)
F8372	large wooden fragment of unspecified object (l: 6.5cm, w: 5.2cm, t: 2.1cm)

Burials

Sk319-1

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 49%
Sex: female
Age: >35 years
Stature: -
Pathologies:

Orbital lesions	porosities
NBF	-
Sinusitis	strong changes in both maxillary and the frontal sinus
Ribs	two left middle ribs, healed
Endocranial changes	HFI
OA	-
IVD	-
Trauma	small, circular depression fracture on left parietal
Dental pathologies	AMTL periapical lesion on ulC
Other pathologies	-

Dental status

R	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Sk319-2

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 20%

Sex: indifferent

Age: adult undet.

Biomolecular: C/O-sample AW3

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	-
Ribs	two left middle ribs, healed
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	slight calculus and periodontal disease DEH
Other pathologies	-

Dental status

R	M3	M2	M1	P4	P3	C	I2/	x	/	/	C	/	/	M1	-	<u>M3</u>	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

<u>Sk319-3</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 44%

Sex: female?

Age: 0–0.5 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-

Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status

R M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk319-4

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3

Completeness: 38%

Sex: male

Age: adult indet.

Stature: -

Pathologies:

Orbital lesions	vessel impressions and remodelled NBF
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	plaque-like NBF in frontal bones increased vessel activity in both parietals along the sagittal suture with strong vessel impressions
OA	cervical and thoracic spine
IVD	cervical and thoracic spine
Trauma	-
Dental pathologies	AMTL periapical lesions on ruM2 and ruM3
Other	-

Dental status

R x	/	x	-	-	-	x	x	x	x	-	-	-	-	M2	M3	L
M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Post-New Kingdom tombs

G300

Superstructure:

Dimensions: d: 6.5m
Description:
The superstructure comprises a shallow tumulus consisting of dug-up debris (alluvial silt and schist rubble) from the tomb, covered with schist stones of 10–30cm.

Shaft:

Dimensions: 1.10m x 0.75m, depth 1.30m
Description:
The shaft [8002] is oval-shaped and vertically carved into the alluvial silt and underlying bedrock in the bottom 0.65m. It was backfilled with deposit [8001] consisting of windblown sand holding disarticulated human remains, fragments of wood and ceramic sherds.

Ceramics

[8001]	C8000	plate with red-painted rim
	C8001	beer jar
	C8100	plate with red-painted rim
	C8101	beer jar
	C8102	red-slipped bowl
	eroded sherds from at least three more vessels including one Nubian pot	

Finds

[8001]	F8001	large amount of pieces of white plaster, some bear wooden and textile impressions, attesting to an association with coffins and/ or funerary beds (l: 9.5cm, w: 7.4cm, t: 2.3cm)

Eastern chamber:

Dimensions: d: 1.20m, h: 0.60m
Number of burials: -
Description:
The eastern burial chamber (cut [8022]), accessible through a narrow, rounded opening of 0.65cm maximal width is very small with an irregular, sub-circular outline. Due to the texture of the surrounding schist stone, the walls are very uneven and only very roughly cut. The chamber was filled to the top with windblown sand mixed with small amounts of schist gravel [8004]. Aside from a small amount of badly deteriorated human remains, wooden and plaster fragments and some pot sherds, the chamber was almost empty suggesting its original content had largely been removed.

Finds

[8004]	F8064	small white pieces of plaster (largest fragment 2.1x1.6x0.4cm)

Western chamber

Dimensions: 1.70m EW x 1.90cm NS, h: 0.70cm
Number of burials: 5
Description:

The western chamber (cut [8027]), also carved into the schist bedrock features a flat floor and rounded, dome-shaped. Access is provided through a narrow, round access with a maximum width of 0.85cm. It was backfilled with windblown sand mixed with a few pieces of the surrounding surface material and bedrock [8005] thought the chamber was only filled up to a half of its height. The chamber contained the commingled, disturbed and heavily fragmentary remains of four adults and one infant. Sk300-1, a 5–6 year old child was placed in the entrance of the chamber, differences in colour and preservation may indicate a later intrusion. Furthermore there were again remnants of coffins or burial beds though they were heavily damaged by termite activity. A large amount of plaster, in some cases bearing imprints of wood and woven fibre was found as well.

Finds

[8005]	F8000	small white pieces of plaster (largest fragment 2.1x1.6x0.4cm)
	F8002	pieces of white plaster with impressions of wood, rope and textile (largest fragment 26.1x6.2x2.3cm)
	F8086	fragments of white plaster, bearing impressions of finely woven fabric (l: 4.4cm, w: 1.6cm, t: 0.5cm)

Burials

Sk300-1/ [8005]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/1
Completeness: 59%
Sex: -
Age: 5-6 years
Biomolecular: C/O-sample AW19
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	-

Trauma	-
Dental pathologies	DEH
Other pathologies	-

Dental status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	M2	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Sk300-2/ [8005]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/4

Completeness: 21%

Sex: male

Age: adult indet.

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	granular impressions in left temporal
OA	-
IVD	-
Trauma	healed fracture to the MtII
Dental pathologies	abscess on ulC and lrC
Other pathologies	healed mastoiditis

Dental status

R	-	-	-	-	-	-	-	-	/	/	/	-	-	-	-	-	L
	-	-	-	-	x	/	/	x	x	x	x	-	-	-	-	-	

Sk300-3/ [8005]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 39%
Sex: male?
Age: adult indet.
Stature: -
Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	NBF in the maxillary and frontal sinus
Ribs	-
Endocranial changes	plaque like bone deposition
OA	RCD in the right shoulder, OA in the elbow, wrist and hand
IVD	-
Trauma	-
Dental pathologies	extensive AMTL abscesses on urC, ruI1 and llM3 dental calculus and periodontal disease
Other pathologies	-

Dental status

R	x	x	x	x	x	x	/	/	x	x	x	x	x	x	x	-	L
	-	-	-	-	-	-	x	x	x	x	/	/	/	/	M2	x	

Sk300-4/ [8005]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 27%
Sex: female
Age: adult indet.

Stature: -
Pathologies:

Orbital lesions	porosities in both orbital roofs
NBF	-
Sinusitis	healed changes in frontal sinus and sphenoid sinus
Ribs	-
Endocranial changes	very deep vessel impressions along A. meningea media
OA	-
IVD	n/a
Trauma	-
Dental pathologies	periapical lesions on rlP2, lrC, llI2
Other pathologies	-

Dental status

R M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

<u>Sk300-5/ [8005]</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 39%
Sex: female?
Age: adult indet.
Stature: 159.4 ± 1.2cm
Pathologies: none
Dental Status: no teeth

G302

Orientation: E–W
Number of burials: 1

Superstructure: -
Substructure:

Dimensions:
Description:
Partially preserved skeleton is only covered by a 5–10cm of windblown sand. [8009] No grave cut could be seen. The bones were heavily eroded, some isolated teeth fragments, a few pieces of ceramic were found together with the skeleton. No finds were associated with the individual, thus its dating remains unclear.

<u>Sk302</u>

Funerary ritual
Body Orientation: N–S
Body Position: flexed
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 2/5
Completeness: 9%
Sex: indifferent
Age: adult
Stature: -
Pathologies: none
Dental status: no teeth

G303

Orientation: E–W
Number of burials: 1

Superstructure: -
Substructure:

Dimensions: 1.80m EW x 0.60m NS, depth: 0.20–0.25m
Description:
The grave features a shallow cut, vertical cut into the alluvium (cut [8020]). It is oval shaped with vertical side walls and slightly sloping head walls, the bottom is flat. While the upper 5cm of the cut were only filled with windblown sand [8019], the lower portion of the fill consists of fine darker, sandy silt dust. While a few vertebrae were disarticulated in the windblown sand, the lower part of the fill contained the undisturbed upper part (mid thoracic vertebrae onwards) of an infant skeleton. The head of skeleton was covered with a basket or other organic

object. Due to lack of datable objects from the grave, dating of the grave remains unknown.

Sk303

Funerary ritual

Body Orientation: E–W
Body Position: extended, on right side
Associated finds:

F8003 badly deteriorated remains of a basket (?), undetermined material (d: 33cm, t: 9.5cm)

Skeleton

Articulation: disarticulated
Bone preservation: 4/4
Completeness: 19%
Sex: indifferent
Age: 2–3 years
Stature: -
Pathologies:

Orbital lesions	porosities in both orbitae
NBF	active NBF visceral side of five right ribs
Sinusitis	-
Ribs	-
Endocranial changes	NBF in frontal base, *Sulcus sinus sigmoideus*, along the impressions of the *A. meningea media* and around area of *F. rotundum* and *F. ovale*
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH
Other pathologies	-

Dental status

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

G305

Orientation: E–W, burial chambers E and W

Superstructure:

Dimensions: d. 8.0m
Description:

The low oval-shaped mound [8047] is formed from alluvial silt, presumably representing the spoil created when the chambers were first excavated during construction of the tomb (see Figure III.12). The surface of the tumulus was covered by a loose scatter of local schist stones (5–40cm, [8048]) and heavily eroded fragments of pottery and human remains. While the human bones likely result from looting, the large amount of pottery may at least partially be explained by deposition of vessels as part of an ancestor cult on the surface. Particularly notable is the significant amount of Napatan sherds despite the absence of vessels of similar date from the interior of the grave. Erosion had severely truncated the tumulus, partially exposing the tops of the eastern and western subterranean burial chambers.

Ceramics

[8048] fragments of at least two beer jars, one bowl, two plates, one black-burnished Nubian vessel, several Napatan marl clay vessels, a red-slipped jar

Shaft:

Dimensions: 2.80x1.20m; depth: 1.2m
Number of burial: 5
Description:

Entrance to the tomb is provided by a rectangular, vertical shaft [8146] in the centre of the tumulus carved into the alluvial silt; its flat bottom coincides with top of the underlying bed-rock. The shaft is lined with mudbrick walls on the northern [8056] and southern side [8057] of the shaft (70cm in height; bricks 37–39x17–18x8–10cm). On the western side, the shaft was originally covered by a mud-brick vault [8051] of 1.90m length and a reconstructed height of 0.30m (see Figures III.9). Only the last course on the north side remains, formed with a single course of thin mud-bricks (32x20x5–6cm), bearing distinctive finger grooves. On the eastern side of the brick-lined chamber, the lack of a vaulted cover created a rectangular shaft (depth 65cm) for access from the surface.

Two narrow brick doorways (western side [8053], eastern side [8052]) provide access from the central chamber to rooms on to the west and east. The entrance to the eastern chamber [8052], perhaps once arched, was originally sealed with a mudbrick wall, and later partly dismantled to allow re-use of the chamber. Though the lintel, threshold and northern side seem to be original, the bricks on the southern side are later additions, perhaps as part of the secondary burials. The shape of the entrance to the western chamber [8053] is even less clear

(0.85x0.45m). Large rectangular schist stone slabs placed on their ends, behind the entrance, may represent remnants of a blocking structure.

The top 0.80cm of the shaft were backfilled by a loose deposit of yellow windblown sand [8045] holding a large amount of sherds, some disarticulated human bones and small wooden fragments. In a depth of 0.80m, the shaft is filled with a deposit of brick fragments [8055]; amongst them some clear vaulting bricks, representing remnants of the collapsed vault. Underneath the collapse, is a dense, disturbed deposit of brick rubble (<10cm, 80% of the deposit) and yellow windblown sand [8068], containing the heavily disturbed and entirely disarticulated remains of at least four different individuals, together with well preserved fragments of wooden objects, some of which could be identified as feet from funerary beds (F8011). It remains unclear whether the individuals were originally buried in the central portion of the chamber or whether they were removed from either of the chambers. Skeletal elements were only found in the western half of the shaft and exclusively represent elements from the upper body as would be expected in west–east orientated burials with the head to the west. Neither of the burial chambers yielded bones that did not belong to the skeletons buried in that chamber: if bodes had been dragged out to clear the side chambers for new burials, it is unlikely some bones would not have been left behind.

Ceramics

[8045]	C8111	hand-made doka vessel
	C8112	jar
	C8113	jar
	fragments of at least two beer jars, one burnished bowl, two marl clay and a Nubian vessel	

Finds

[8045]	F8011	dark brown wooden fragments belonging to a funerary bed or other wooden objects (max. 3.7x2.8x2.0cm)
[6068]	F8015	fragments of highly degraded wood or fibre
	F8017, F8018	fragments of basketry (max 3.4x1.3x1.2cm)
	F8020	large amount of small wooden fragments with some clearly worked edges (max. 4.4x1.8x1.2cm)

Burials

Sk305-7

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 13%

Sex: indifferent
Age: 3–5 years
Stature: -
Pathologies:

Orbital lesions	strong porosities in both orbits
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	remodelled NBF, porosities and increased vessel impressions in skull base and occipital bone
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	remodelled NBF on both greater sphenoid wings

Dental status

R	dM1	dM2	dC	/	/	/	/	dC	dM1	dM2	L
	-	-	-	-	-	/	dI2	dC	dM1	dM2	

Sk305-8

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 20%
Sex: indifferent
Age: 21–35 years
Stature: -
Pathologies:

Orbital lesions	porosities
NBF	-
Sinusitis	healed in both maxillary and the frontal sinus
Ribs	at least three left ribs with mixed NBF visceral
Endocranial changes	marked impressions of both meningeal arteries, very small granular impressions with possible new bone formation in the posterior parts of parietals strong granular impressions in occipital remodelled NBF in base of both temporal bones and left

	sigmoid sulcus
OA	thoracic spine
IVD	-
Trauma	-
Dental pathologies	slight calculus and periodontal disease
Other pathologies	erosive changes along margins of both humeral heads

Dental status

R	M3	/	/	/	/	/	/	/	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Sk305-9

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 17%
Sex: indifferent
Age: adult undet.
Stature: 166.9 ± 1.9cm
Pathologies:

Orbital lesions	porosities in both orbitae
NBF	remodelled NBF ventral on right scapular blade
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	all sections of spine
IVD	all sections of spine
Trauma	healed double fracture on the left scapula affecting the acromion and scapular blade (see Figure III.119)
Dental pathologies	-
Other pathologies	potentially evidence of DISH through ossification of anterior longitudinal ligament

Dental status: no teeth

Sk305-11

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 10%

Sex: indifferent

Age: adult undet.

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	n/a
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a
OA	-
IVD	-
Trauma	-
Dental pathologies	AMTL strong calculus and periodontal disease
Other pathologies	

Dental status

R -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
M3	x	x	x	x	x	x	x	x	x	x	x	x	x	/	x	

Eastern chamber:

Dimensions: 2.0m EW x 2.0m NS, height: 1.15m

Number of burials: 2

Description:

The sub-rectangular burial chamber was entirely carved into the alluvial silt, featuring straight, vertical walls and a flat floor coinciding with top of the bedrock (cut [8098]). The ceiling of the chamber had been largely lost due to wind erosion and partially collapsed into the chamber. The upper fill [8050] consists of yellow windblown sand mixed with a small amount of silt gravel, mud brick rubble and schist stones, and held a few eroded sherds and disturbed human bones. It covers a solid, dense layer of silt rubble [8050] with a depth of 15–30cm representing collapse of the ceiling. Underneath the rubble, a small deposit of clean windblown sand [8103] was recovered adjacent to the entrance, sloping towards the back of chamber. It represents sand which entered the chamber through the open doorway when the ceiling was still intact and covers a deposit of mud brick and plaster fragments representing remnants of the destroyed door blocking structure [8108].

Two burials were recovered from the chamber, superimposed; leading to the conclusion they were not entirely in their original burial position. The lower skeleton (Sk305-1, [8105]) was buried in an extended position orientated north-south, the upper one (Sk305-2, [8101]) is a slightly flexed burial with the head to the east. Both bodies were again surrounded by remnants of dark organic substance, and textiles adhered to the skeletons. Given their fragmentary state, it is not yet clear whether the organic brown material represents the remains of coffins or rather matting in which the bodies were wrapped; archaeobotanical analysis will be undertaken in due course. Apart from a single blue faience bead (F8061) associated with Sk305-1 no objects were recovered from the chamber. Further grave goods [8106] are limited to a beer jar (C8012) and a plate (C8013), resting next to each against the northern wall of the chamber. Three large schist stones resting flat on the floor may have been intended to lift the wooden coffins off the floor, as in G301.

Ceramics

[8106]	C8012	beer jar
	C8013	plate with red-painted rim

Burials

<u>Sk305-1/ [8105]</u>

Funerary ritual

Body Orientation: E-W

Body Position: extended, supine

Associated finds:

F8044 outer wrapping of the body

Skeleton

Articulation: articulation

Bone preservation: 5/2

Completeness: 84%

Soft tissue: hair SS16, soft tissue under thorax SS20

Sex: female

Age: 36–50 years

Stature: 156.6 ± 1.2cm

Pathologies:

Orbital lesions	-
NBF	left femur medial both tibiae lateral and fibulae entire shaft, remodelled
Sinusitis	n/a
Ribs	healed on four left and three right of middle and lower thoracic cage
Endocranial changes	-
OA	TMJ, ACJ, left elbow, right hand, knees (see Figure III.100), ankles and feet cervical, thoracic and lumbar spine
IVD	cervical and lumbar spine
Trauma	fracture of vertebral body of Th12 fracture of Patella
Dental pathologies	slight dental calculus, severe periodontal disease ATML, caries periapical lesions on urC, ulI2, ulC, ulP3
Other pathologies	medial arterial calcification along both femoral arteries

Dental status

R	x	x	x	x	x	C	x	I1	I1	I2	C	x	P4	M1	x	x	L
	x	x	x	P4	P3	C	x	x	x	x	/	P3	x	x	x	x	

<u>Sk305-2/ [8100]</u>

Funerary ritual

Body Orientation: E-W

Body Position: extended, supine

Associated finds:

F8041 inner, finer wrapping of the body

F8042 outer, coarse wrapping of the body

F8061 copper alloy fragment, (l: 1.0cm, d: 0.3cm)

F8065 fibre knot

Skeleton

Articulation: articulated

Bone preservation: 4/3

Completeness: 93%

Soft tissue: brain tissue SS9, soft tissue in pelvic area SS9, SS12

Sex: male?

Age: 36–50 years

Stature: -
Pathologies:

Orbital lesions	vessel impressions, porosity and NBF in right orbital roof
NBF	active on right scapular blade healed on both fibulae on distal end active in nasal cavity
Sinusitis	healed on both sides
Ribs	active NBF on visceral side of at least five left and five right ribs
Endocranial changes	hypertrophy, NBF and vessel impressions in *Sulcus sinus sagittalis, Sinus sulcus sigmoideus* and along grooves of the *A. meningea media* (see Figure III.95)
OA	right TMJ, both wrists and hands, hips, right knee and right ankle cervical, thoracic and lumbar spine
IVD	cervical, thoracic and lumbar spine
Trauma	fracture of base of first Metacarpal left fracture of 12th rib left
Dental pathologies	caries AMTL (see Figure III.73) periapical lesions on urC, llP4 and llM1 moderate dental calculus
Other pathologies	RCD calcification, hyoid cyst? SS11

Dental status

R	-	<u>M2</u>	x	x	x	x	I2	I1	x	x	x	x	x	x	x	-	L
	M3	M2	M1	P4	P3	x	x	x	x	x	<u>C</u>	<u>P3</u>	<u>P4</u>	M1	M2	M3	

Western chamber:

Dimensions: 2.20m NS x 2.00m EW, remaining height: 1.20m
Number of burials: 4
Description:

The burial chamber is of roughly sub-circular outline with a flat, uneven but smooth floor comprising the top of the bed rock (cut [8099]). The ceiling had partially eroded, partially collapsed into the chamber, leaving the top of the chamber exposed. The upper part of the chamber until a depth of 30cm below surface was backfilled with windblown yellow sand [8060] mixed with debris from the collapsed ceiling. [8060] further contained schist slabs up to 100cm, presumably from destroyed ceiling structure, as well as disarticulated fragmentary human bones and sherds. It covers a dense, dark deposit of ceiling collapse with a thickness of 40–50cm [8097]. Underneath the ceiling collapse is another deposit of loose, sterile, yellow windblown sand [8104] covering 75% of the chamber. Its highest point is adjacent to the doorway indicating that it entered after opening of the blocking structure. On top of this deposit is an extended articulated, W–E aligned burial Sk305-3 ([8109], young adult female) buried in a doum palm coffin, which represents a later phase of use. The legs of the burial, reaching into the shaft had been disarticulated.

Underneath [8104], three superimposed burials resting on the floor of the chamber were recovered. Only the top one (middle adult female Sk305-4, [8110]) is fully intact. Skeletons 305-5 and 305-6 were partly disturbed, even though major articulations remained intact, indicating that their disturbance occurred not long after their burial. Skeleton 305-4 was orientated head to the north and feet to the south even though there are indications that this was in fact not its original burial position; remnants of wood around the body suggest it may have once been within a coffin. Small fragments of textile, now adhering to the bones, indicate that the body was wrapped, a conclusion supported by the position of some bones. The lower burials were covered with a 40cm thick deposit of fine sand, blown in through the door. The preservation of human remains is very good and also comprises remnants of hair, skin and brain tissue, and coprolites.

Ceramics

[8060] fragments of one jar, one Nubian vessel, one Napatan marl clay vessel and one red-rimmed plate

Burials

<u>Sk305-3/ [8109]</u>

Funerary ritual

Body Orientation: W–E

Body Position: extended, supine

Associated finds:

F8047 doum palm coffin, fragmentary, (max. 6.1x1.0x0.7cm), BS49

F8060 fragments of wood with remnants of textile, (max 3.5x1.6x2.4cm)

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 67%

Sex: female?

Age: 21–35 years

Stature: 154.8 ± 3.2cm

Biomolecular: C/O-sample AW11

Pathologies:

Orbital lesions	vessel impressions and NBF in both orbitae
NBF	nasal cavity*, canalis lacrimalis* and on both zygomatic bones mixed NBF on both scapular blades ventral
Sinusitis	severe, healed NBF
Ribs	visceral, on shaft of at least five right and four left ribs

Endocranial changes	vessel impressions in *Sulcus sinus sigmoideus* and on temporal (A. meningea media) and around area of *Foramen rotundum* and *Foramen ovale*
OA	right mandibular condyle, both ACJ, right shoulder, both hands, both hips, left knee, all sections of the spine
IVD	all sections of the spine
Trauma	healed fractures of four left ribs fractured mandibular condyle healed fracture on right 5th metacarpal
Dental pathologies	severe calculus and periodontal disease periapical lesion on ulI1, lrP3, llP4 caries
Other pathologies	RCD

Dental status

R	x	x	M1	P4	P3	C	I2	I1	I1	x	C	P3	P4	x	x	x	L
	M3	x	x	P4	P3	C	I2	I1	I1	I2	C	/	P4	x	M2	x	

Sk305-4/ [8110]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8049 remnants of wood furniture, (max. 5.0x1.8.x1.2cm), unclear origin, BS56

Skeleton

Articulation: partially disarticulated

Bone preservation: 5/2

Completeness: 89%

Soft tissue: soft tissue underlying pelvis SS22

Sex: female

Age: 36–50 years

Pathologies:

Orbital lesions	strong vessel impressions in both orbitae
NBF	healed on both tibiae and fibulae along medial third of shaft
Sinusitis	healed NBF in both maxillary sinuses
Ribs	healed visceral on three medial ribs
Endocranial changes	HFI slight bone NBF in skull base and *sulcus sinus sigmoideus*
OA	right TMJ and ACJ, both hands, knees, right ankle and foot

	all sections of the spine
IVD	cervical and lower thoracic spine
Trauma	healed fracture of 2nd right metacarpal healed fracture on upper rim of vertebral body of Th3
Dental pathologies	caries DEH severe periodontal disease hypercementosis on urM1, urP3, urC and ulM1 AMTL with extensive inflammatory changes
Other pathologies	-

Dental status

R	x	x	M1	x	P3	C	x	x	x	x	x	x	P4	x	x	x	L
	x	x	x	/	/	x	x	x	x	I2	C	P3	x	x	x	x	

<u>Sk305-5/ [8113]</u>

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: partially disarticulated

Bone preservation: 5/3

Completeness: 71%

Soft tissue: remnants of skin SS21

Sex: female

Age: 21–35 years

Stature: 160.3 ± 2.1cm

Pathologies:

Orbital lesions	
NBF	left fibula distal third
Sinusitis	
Ribs	healed NBF visceral on five right and three left ribs
Endocranial changes	
OA	all sections of the spine both ACJ and shoulders, both hips, knees and feet
IVD	-
Trauma	healed fracture of the left clavicle (distal third) healed fracture of shaft of one right middle rib
Dental pathologies	caries AMTL

Other pathologies	

Dental status

R	-	-	-	-	-	/	/	/	/	/	/	x	/	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Sk305-6/ [8113]

Funerary ritual

Body Orientation: -

Body Position: extended?

Associated finds: -

Skeleton

Articulation: partially disarticulated

Bone preservation: 5/2

Completeness: 49%

Sex: male?

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	-
NBF	both fibulae, medial third of shaft
Sinusitis	n/a
Ribs	at least two left and two right ribs visceral healed NBF
Endocranial changes	-
OA	left shoulder, right hip, both knees, right foot cervical and thoracic spine
IVD	cervical and thoracic spine
Trauma	healed vertebral body fracture Th5 healed fractures of right 3rd and 5th metacarpals healed fracture of 5th metatarsal and proximal phalanx
Dental pathologies	AMTL periapical lesions on urP3, urC, ulC, lrC and urC
Other pathologies	-

Dental status

R	x	x	x	x	x	/	x	/	x	x	x	x	x	x	x	x	L
	x	x	x	x	x	/	x	x	x	x	/	/	x	x	x	x	

G311

Orientation: E–W
Number of burials: 1

Superstructure:

Dimensions: d: 5.50m
Description:
G311 features a small circular superstructure comprising schist rubble and alluvial silt.

Shaft:

Dimensions: 1.20m EW x 0.55m NS, d: 1.30m
Description:
The oval shaped grave cut is vertically carved into the alluvial silt. It was backfilled with windblown yellow sand. Disarticulated skeletal remains of one neonate burial [8205] were recovered from the upper layers of the fill. It remains unclear whether this is the original burial (the small size of the chamber would indicate so) or whether this represents a later phase of use. From a depth of 0.80m below current surface level, the shaft was filled with a darker deposit of soft, sandy deposit of silt material. This deposit was void of finds.

Sk311

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: articulated
Bone preservation: 4/2
Completeness: 55%
Sex: indifferent
Age: neonate
Stature: -
Pathologies:

Orbital lesions	-
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-

IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

G314

Orientation: E–W, burial chambers E and W

Superstructure:

Dimensions: -
Description: -

Ceramics

[8217]	C8134	handmade vessel with incisions, fragments
	C8135	handmade vessel/ cooking pot, fragments

Shaft:

Dimensions: 1.10m EW x 0.80m NS, depth: 1.30m
Description:

Entrance to the tomb is provided by an oval shaft vertically carved vertically into the alluvial silt (cut [8218]). The bottom of the shaft is flat and coincides with the surface of the underlying schist bedrock. The shaft was covered and filled with a large amount of large schist stones and slabs [8213]/ [8215]. It remains unclear whether they derived from a shaft covering structure, blocking structures to the doorways or where deliberately placed to block the shaft even though due to their large number they cannot only represent remnants of a destroyed blocking structure. Placement of the slabs does not indicate any particular order or pattern. No bonding material was observed surrounding the slabs Surrounding the slabs was yellow, windblown sand, with no clear evidence of bonding material. On the bottom of the shaft, the shaft is filled with a 20cm thick deposit [8215] of debris from the blocking structures (mud plaster fragments), disarticulated human remains and fragmented vessels, mixed with windblown sand.

The narrow, rectangular entrance to the eastern chamber (h: 0.85m, w: 0.60m) had originally been blocked by schist stones and mud plaster, even though only the bottom section ([8252], h: 0.35m) remained intact. The blocking structure of the entrance to the western burial chamber (h: 0.60m, w: 0.85m) was reduced to mud plaster [8253] on the bottom of the shaft. An articulated burial Sk314-9 was recovered partially within the shaft, and may have been dislocated during looting.

Ceramics

[8215]	C8045	jar with red slip

	C8136	bowl with red-pained rim
	C8138	bowl with neck, red-burnished
	C8139	pilgrim-flask
	C8140	pilgrim-flask
	C8141	bowl

Finds

[8215]	F8200	fragment of bone or ivory (l: 1.2cm, w: 0.2cm, t: 0.2cm)
	F8206	fragments of wood from unspecified object (max. 5.6x1.4x0.7cm)

Eastern burial chamber:

Dimensions: 2.05m EW x 1.80m NS, height: 0.65m

Number of burials: 13

Description:

The sub-circular burial chamber was carved into the alluvial silt, featuring vertical, straight walls with parallel chisel marks (cut [8221]). The flat floor coincides with surface of the bedrock, its even texture suggests preparation. The chamber had originally not been backfilled. The content of the chamber was covered by a deposit of windblown sand [8219] filling the chamber of the 30cm above floor level. Mixed within the windblown sand is a large amount of ceramic fragments, skeletal fragments and fragments of wooden objects; further attesting to disturbance of the chamber.

The burials are located in the eastern two thirds of the chamber. In the centre are two partially articulated individuals Sk314-1 and Sk314-2 superimposed on a funerary bed. Further individuals Sk314-3 and Sk314-4 were found directly underneath the funerary bed. Wooden fragments [8417] indicate the presence of at least one more funerary bed. At least one basket was placed on the northern side (see Figure III.55). Sk314-2 as well as the sub-adult burial Sk314-5 was buried in a flexed position, in contrast to all other individuals which were buried extended. Three more articulated individuals (one adult Sk314-7 and two sub-adults Sk314-6 and Sk314-12) were recovered from the chamber, partially superimposed and varying in orientation between N–S and E–W, perhaps indicating the burials were not in their original position but displaced during episodes of looting and/or re-use. Wooden remains found in association with the sub-adult individuals possibly indicate funerary containers comprising matting or wrapping with circular wooden objects running parallel to the body axis but due to commingling, overlay and deterioration this is difficult to ascertain.

The back of the chamber is filled with a dense deposit [9421] containing entirely disarticulated human remains of three more individuals as well as a large amount fragments of wooden objects. These presumably derived from the earliest phases of burial and were removed to create space for subsequent burials.

Ceramics

[8219]	C8046	pilgrim flask
	C8047, C8055	bowl with red-painted rim
	C8048, C8049, C8204	red-burnished bowl

	C8050	red-burnished plate
[8232]	C8205	handle of pilgrim flask, possibly part of C8046
[8421]	C8202	bowl with red-painted rim

Finds

[8219]	F8201	large scarab in green faience, glaze partially preserved, cartouche of Amenhotep III surrounded by two erected cobra facing each other (see Figure III.55)
	F8202	bead, glazed composition
	F8203	basket, fragmentary (l: 12.8cm, w: 6.6cm)
	F8205	necklace or bracelet made of circular disc beads (approx. 148) in blue and green faience, parts of the sting preserved (d: 0.4cm, t: 0.1cm)
	F8206	very small fragment of copper alloy (l: 0.5cm, w: 0.4cm, t: 0.3cm)
	F8210	large amount of fragments of wood, no diagnostic pieces (max. 6.6x2.8x1.2cm)
	F8211	fragments of rope, one fragment with traces of white plaster on the surface (d: 0.7–0.8cm)
	F8212	fragments of plaster and stringing from funerary bed (max. 5.2cm, w: 2.7cm, t: 1.5cm)
	F8420	fragments of textile (max 2.5x1.1cm)
[8232]	F8417	undiagnostic wooden fragments (max. l: 8.5cm, w: 3.6cm, t: 1.8cm)
	F8426	undiagnostic wooden fragments (max. l: 10.8cm, w: 3.1cm, t: 2.3cm)
	F8430	cross-beam fragments (max. l: 14.0cm, w: 1.6cm, t: 1.4cm)
	F8435	small fragments of wood or reed, undiagnostic
[8417]	F8422	sub-cylindrical wood fragments: cross beam (max. l: 2.5cm, d: 0.5cm)
	F8423	large sub-cylindrical wood fragments from cross beam (max. l: 9.0cm, w: 1.0cm, t: 0.8cm)
	F8424, F8425	funerary bed, fragments from the eastern side with stringing partially preserved (max. l: 6.6cm, w: 2.7cm, t: 1.5cm)
[8421]	F8434	fragments of wood with thread wrapped around (max. l: 3.8cm, d: 0.8cm)
	F8442	knot from fibre (l: 2.2cm, w: 1.5cm, t: 1.0cm)
	F8446	large amount of wooden fragments from unknown objects, some with circular or curving shape (max. l: 9.2cm, d: 1.0cm)
	F8450, F8451	large amount of undiagnostic wooden fragments (max. l: 11.5cm, w: 2.8, t: 2.0cm)
	F8457	fragments of basketry, BS295

Burials

<u>Sk314-1/ [8225]</u>

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

F8204	funerary bed, wood, white and greyish plaster fragments (max. 15.0x2.0x1.5cm), white plaster shows traces of black, red and blue paint
F8207	element from funerary bed (l: 9.2cm, w: 3.5cm, t: 3.3cm)
F8208	small fragments of textile (threads max. 2.5cm, articulated fragments max. 1.5x1.5cm)
F8419	small fragments of textile (max. 1.4x0.8cm)

Skeleton

Articulation: partially articulated
Bone preservation: 5/2
Completeness: 48%
Sex: female
Age: 25–35 years
Stature: 161.7 ± 0.9cm
Pathologies:

Orbital lesions	vessel impressions
NBF	-
Sinusitis	-
Ribs	healed visceral on at least six right and six left
Endocranial changes	HFI NBF in frontal bone
OA	both TMJ, right ACJ, both shoulders, right hip and both knees thoracic and lumbar spine
IVD	-
Trauma	-
Dental pathologies	caries abscesses on ulC, ulP3, ulM1 and llM2
Other pathologies	-

Dental status

R	-	-	-	-	-	C	-	-	-	-	-	-	P4	x	x	x	L
	x	x	x	/	/	/	/	/	/	/	/	/	P4	x	x	/	

Sk314-2/ [8225]

Funerary ritual

Body Orientation: N–S
Body Position: flexed, on left side
Associated finds:

F8204	funerary bed, wood, white and greyish plaster fragments (max. 15.0x2.0x1.5cm), white plaster shows traces of black, red and blue paint
F8207	element from funerary bed (l: 9.2cm, w: 3.5cm, t: 3.3cm)
F8208	small fragments of textile (threads max. 2.5cm, articulated fragments max. 1.5x1.5cm)

F8419 small fragments of textile (max. 1.4x0.8cm)

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: 65%

Sex: female

Age: >50 years

Stature: -

Pathologies:

Orbital lesions	-
NBF	NBF on both tibiae and fibulae of mixed activity, affecting both circumferentiae
Sinusitis	healed NBF
Ribs	mixed activity three right and four left of mid to lower rib cage visceral
Endocranial changes	healed NBF along meningeal grooves in parietals, patches of very deep vessel impressions and meningeoma on right parietal bone
OA	both TMJ, both ACJ, both elbows, hips, knees and feet thoracic and lumbar spine
IVD	thoracic spine
Trauma	-
Dental pathologies	moderate calculus and periodontal disease DEH
Other pathologies	RCD

Dental status

R	-	M2	M1	P4	P3	C	/	I1	-	-	-	-	P4	/	/	/	L
	M3	M2	M1	P4	/	C	I2	I1	I1	I2	/	/	P4	M1	M2	/	

Sk314-3/ [8230]

Funerary ritual

Body Orientation: N–S

Body Position: extended, prone

Associated finds:

F8213 fragments of wood and textile

F8418 matting or textile fragments, individual strands (d: 0.2–0.3cm), BS269 (species identification failed, grass or plant stems)

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 67%
Sex: male?
Age: 21–35 years
Biomolecular: C/O-sample AW8
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	thoracic and lumbar spine
IVD	-
Trauma	
Dental pathologies	
Other pathologies	-

Dental status

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk314-4/ [8420]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds:

F8436 small wooden fragments, unspecified funerary container (max. 3.7x1.7x.0.5cm), BS273

F8437 fragments of wood of unspecified funerary container wrapped with vegetal fibre (max. l: 6.1cm, d: 0.7cm)

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 47%
Sex: indifferent
Age: 3–4 years
Stature: -
Pathologies:

Orbital lesions	-
NBF	active NBF on frontal bone ectocranial
Sinusitis	-

Ribs	active NBF visceral side of three right and five left ribs
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status

R	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

Sk314-5/ [8423]

Funerary ritual

Body Orientation: NW–SE

Body Position: flexed, on the right side

Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 4/2

Completeness: 55%

Sex: indifferent

Age: 1–2 years

Stature: -

Pathologies:

Orbital lesions	porosities in both orbitae, NBF on lateral side walls
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	NBF on the floor of both greater sphenoid wings
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH
Other pathologies	-

Dental status

R		dM1	dC	/	/	/	/	dC	dM1	dM2	L

-	-	/	/	/	/	/	/	/

Sk314-6/ [8419]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8431	small wooden fragments from funerary container (max. l: 4.5cm, w: 0.9cm, t: 0.8cm)
F8438	fragments of cylindrical box (max. l: 6.3cm, w: 1.4cm, t: 1.0cm)
F8439	long, thin wooden fragments (max. l: 5.7cm, w: 0.8cm, t: 0.5cm)
F8441	two spherical beads: faience (0.4x0.3cm) and metal (gold?, 0.3x0.2cm)

Skeleton

Articulation: articulated

Bone preservation: 5/2

Completeness: 67%

Soft tissue: remnants of tissue between ribs SS43

Sex: indifferent

Age: 9–11 years

Stature: -

Pathologies:

Orbital lesions	porosities and hypertrophy
NBF	porosity on temporal towards sphenoid
Sinusitis	NBF in frontal sinus
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH
Other pathologies	necrosis on distal femur epiphyses

Dental status

R		M2	M1	-	-	-	-	-	-	-	-	-	-	-	-	-	L
		-	M1	-	-	-	-	-	-	-	-	-	-	M1	-	-	

Sk314-7/ [8422]

Funerary ritual

Body Orientation: NW–SE

Body Position: extended, supine

Associated finds:

F8204 unspecified funerary container, large amount of small wooden fragments, BS280

Skeleton

Articulation: articulated

Bone preservation: 5/3

Completeness: 57%

Sex: female?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	vessel impressions and remodelled NBF
NBF	remodelled NBF on left tibia mid-shaft
Sinusitis	remodelled NBF
Ribs	strong healed changes on at least 4 middle ribs in angle and shaft area
Endocranial changes	marked thickening of the frontal bone
OA	all sections of the spine left TMJ, both scapulae, right elbow, both wrists and hands (see Figure III.101, both hips, knees and feet
IVD	all sections of the spine
Trauma	vertebral body fracture L5
Dental pathologies	abscess llM2 and llM3 calculus and periodontal disease caries DEH
Other pathologies	-

Dental status

R	M3	M2	-	-	P3	x	I2	I1	I1	/	C	x	x	-	-	-	L
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	M2	M3	

Sk314-9/ [8421]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3
Completeness: 52%
Sex: female?
Age: 36–50 years
Stature: -
Pathologies:

Orbital lesions	vessel impressions in both orbital roofs, right cavity of ~ 7mm diameter with surrounding new bone formation (see Figure III.81)
NBF	active NBF visceral side of five right ribs
Sinusitis	n/a
Ribs	-
Endocranial changes	plate-like NBF in frontal bone along sinus sagittalis
OA	cervical, thoracic and lumbar spine both TMJ, both ACJ, left shoulder, both elbows, hips and knees
IVD	thoracic and lumbar spine
Trauma	vertebral body fractures of Th7, L4, L5, S4, S5 healed fracture of one distal phalanx foot
Dental pathologies	extensive AMTL
Other pathologies	-

Dental status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	x	x	x	x	x	/	/	/	/	/	/	x	x	x	x	x	

Sk314-12/ [8424]

Funerary ritual

Body Orientation: S–N
Body Position: extended, supine
Associated finds: -

Skeleton

Articulation: articulated
Bone preservation: 5/2
Completeness: 37%
Sex: indifferent
Age: 0–0.5 years
Stature: -
Pathologies:

Orbital lesions	-
NBF	-

Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

Sk314-16/ [8219], [8232], [8241]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 52%
Sex: male
Age: 36–50 years
Stature: 165.8 ± 2.7cm
Pathologies:

Orbital lesions	vessel impressions and NBF in both orbital roofs
NBF	healed on right tibia medial and lateral side of shaft
Sinusitis	healed NBF in frontal sinus, maxillary sinus n/a
Ribs	visceral healed changes on two right middle ribs
Endocranial changes	-
OA	both elbows, hips, both feet cervical, thoracic and lumbar spine
IVD	cervical, thoracic and lumbar spine
Trauma	healed fracture of atlas neural arch (see Figure III.123) healed fracture of spinous process of Th8 healed on one right rib
Dental pathologies	AMTL periapical lesions on urP4, urC, urI2, urI1, ulI2, llP4, lrI2
Other pathologies	School's nodes in thoracic and lumbar spine

Dental status

R	x	x	x	x	x	/	x	x	/	x	/	x	/	-	-	-	L
	/	x	x	x	/	/	/	/	/	/	/	/	x	x	x	x	

<u>Sk314-17/ [8219], [8232], [8241]</u>

Funerary ritual
- Body Orientation: -
- Body Position: -
- Associated finds: -

Skeleton
- Articulation: disarticulated
- Bone preservation: 5/2
- Completeness: 46%
- Sex: male
- Age: 17–20 years
- Stature: 163.2 ± 2.1cm
- Pathologies:

Orbital lesions	n/a
NBF	remodelled lateral on left proximal femur active on both tibiae medial and lateral side of the shaft
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

<u>Sk314-18/ [8219], [8232], [8241]</u>

Funerary ritual
- Body Orientation: -
- Body Position: -
- Associated finds: -

Skeleton
- Articulation: disarticulated
- Bone preservation: 5/3
- Completeness: 38%

Sex: indifferent
Age: 7–12 years
Stature: -
Pathologies:

Orbital lesions	porosities on right orbit
NBF	-
Sinusitis	-
Ribs	-
Endocranial changes	-
OA	-
IVD	n/a
Trauma	-
Dental pathologies	DEH on permanent teeth
Other pathologies	-

Deciduous dentition

R	/	/	/	/	/	/	/	/	M1	M2	L
	-	-	-	-	-	-	-	-	-	-	

Permanent dentition

R	-	-	/	nE	nE	/	/	/	/	/	/	nE	nE	M1	/	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

<u>Sk314-19/ [8232], [8241]</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/3
Completeness: 15%
Sex: indifferent
Age: 2–3 years
Stature: -
Pathologies:

Orbital lesions	porosities, NBF on floor of orbital cavity
NBF	-
Sinusitis	n/a
Ribs	-

Endocranial changes	NBF on skull base in frontal and occipital bone
OA	-
IVD	n/a
Trauma	-
Dental pathologies	-
Other pathologies	-

Dental status: no teeth

Western chamber:

Dimensions: 2.05m EW x 2.10m NS, height: 0.75m
Number of burials: 8
Description:

The western burial chamber is sub-circular, the walls and ceiling are somewhat rounded while the bedrock surface creates are flat, even floor. Similar to the eastern burial chamber, the western chamber had not originally been backfilled but gradually filled up with windblown sand [8220] entering through the doorway. Eight individuals were buried in the western chamber, again superimposed in three layers of skeletons. Only three adult individuals were intact, while in Sk314-11 and Sk314-14 lower extremities were missing. Orientation varied between N–S and E–W. In contrast to the eastern chamber, no clearly identifiable funerary containers were recovered. The distinctively smaller amount of wooden fragments remains unspecified. Two individuals, Sk314–8 and Sk314-14 featured remnants of a coarse wrapping textile. The back of the chamber also held a significant amount of fragmentary disturbed bones [8238], comprising both elements of the partially articulated individuals but also fully disarticulated individuals.

Ceramics

[8220]	C8053	bowl with red-painted rim

Finds

[8220]	F8214	large amount of un-diagnostic wooden fragments
	F8215	large amount of un-diagnostic wooden fragments (max. 4.7x4.0x2.7cm)
	F8217	fragments of textile or matting
[8243]	F8218	copper alloy fragment (l: 1.1cm, w: 0.7cm, t: 0.4cm)

Sk314-8/ [8236]

Funerary ritual

Body Orientation: E–W
Body Position: extended, prone
Associated finds:

F8219 small fragments of wood and fibre (max. l: 6.7cm, d: 0.8cm)

Skeleton

Articulation: articulated

Bone preservation: 5/3

Completeness: 70%

Sex: female

Age: 20–30 years

Stature: 160.3 ± 1.3cm

Pathologies:

Orbital lesions	hypertrophy and porosities in both orbitae
NBF	-
Sinusitis	active NBF
Ribs	-
Endocranial changes	-
OA	left hip
IVD	-
Trauma	-
Dental pathologies	DEH caries calculus and periodontal disease periapical lesions on lrM1, l2I1 and llM1
Other pathologies	-

Dental status

R	<u>M3</u>	M2	M1	P4	P3	C	I2	I1	/	I2	C	P3	P4	M1	M2	M3	L
	M3	M2	M1	P4	P3	C	I2	I1	I1	I2	C	P3	P4	M1	M2	M3	

<u>Sk314-10/ [8240]</u>

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: articulated

Bone preservation: 4/4

Completeness: 67%

Sex: female

Age: 36–50 years

Stature: 154.2 ± 4.2cm

Pathologies:

Orbital lesions	porosities in both orbitae
NBF	healed NBF on both tibiae and fibulae along entire shaft
Sinusitis	-
Ribs	at least three left ribs visceral healed changes
Endocranial changes	NBF in frontal base, *Sulcus sinus sigmoideus*, along the impressions of the *A. meningea media* and around area of *F. rotundum* and *F. ovale*
OA	all sections of the spine right TMJ, both shoulders, both elbows, left hand, both ribs, both hips, knees, ankles and feet
IVD	thoracic and lumbar spine
Trauma	-
Dental pathologies	AMTL moderate calculus and periodontal disease
Other pathologies	-

Dental status

R	-	-	-	/	/	/	/	I1	/	/	/	P3	P4	M1	M2	M3	L
	x	x	x	/	/	/	/	/	/	/	/	/	x	x	x	x	

Sk314-11/ [8241]

Funerary ritual

Body Orientation: E–W

Body Position: extended, supine

Associated finds: -

Skeleton

Articulation: partially articulated

Bone preservation: 4/4

Completeness: 31%

Sex: male

Age: 21–35 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	healed on tibiae and fibulae
Sinusitis	healed in both maxillary sinuses
Ribs	-
Endocranial changes	HFI (see Figure III.87)
OA	thoracic spine right elbow, both hips
IVD	-
Trauma	-

Dental pathologies	periapical lesion on urI1, urI2, ulI1, llC moderate calculus DEH
Other pathologies	-

Dental status

R	x	x	x	x	x	/	/	/	/	x	-	-	-	-	-	-	L
	-	-	M1	P4	-	-	I2	-	x	x	-	-	-	-	-	-	

Sk314-13/ [8238]

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/3

Completeness: 33%

Sex: indifferent

Age: 4–5 years

Stature: -

Pathologies:

Orbital lesions	porosities and woven bone
NBF	active in both scapulae (*fossa supraspinalis*), left mandibular ramus, left proximal endplate of humerus temporal and sphenoid bones
Sinusitis	n/a
Ribs	-
Endocranial changes	porosities in parietal bones, NBF in *Sulcus sinus sigmoideus*
OA	-
IVD	n/a
Trauma	-
Dental pathologies	DEH on permanent tooth crowns caries on deciduous teeth
Other pathologies	probable evidence of scurvy

Deciduous dentition

R	m2	/	/	/	/	/	/	C	/	m2	L
	/	/	/	/	/	/	/	/	m1	m2	

Permanent dentition

R		M2	M1				I2	I1		I2	C			M1	M2		L
		-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Sk314-14/ [8248]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8216 coarse wrapping textile from reed or plant stem, BS 248 (no species identification possible)

Skeleton

Articulation: articulated

Bone preservation: 4/3

Completeness: 65%

Sex: male

Age: 15–18 years

Biomolecular: C/O-sample AW6

Pathologies:

Orbital lesions	porosities
NBF	active ventral on sacral bodies S3 and S4 active in mastoid process
Sinusitis	active
Ribs	visceral on right 11th and 12th rib
Endocranial changes	-
OA	-
IVD	-
Trauma	-
Dental pathologies	DEH mild calculus and periodontal disease periapical lesion on ulP3, llC caries
Other pathologies	Mastoiditis

Dental status

R	M3	/	M1	/	P3	/	I2	I1	I1	I2	C	/	P4	M1	M2	M3	L
	M3	/	/	/	/	/	/	I1	I1	/	C	x	P4	x	x	M3	

Sk314-15/ [8249]

Funerary ritual

Body Orientation: N–S
Body Position: extended, supine
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 4/3
Completeness: 50%
Sex: male
Age: 36–50 years
Stature: 164.9 ± 2.5cm
Pathologies:

Orbital lesions	very deep vessel impressions
NBF	active changes on both tibiae on lateral side of shaft
Sinusitis	healed NBF in frontal sinus
Ribs	visceral healed on at least six right ribs
Endocranial changes	small plaque like bone deposition in frontal bone
OA	left ACJ, both shoulders, left elbow, both wrists, hands, right ankle, right knee all sections of the spine
IVD	cervical, thoracic and lumbar spine
Trauma	healed fracture of left 2nd metacarpal healed fracture of left patella healed fracture head of 12th left rib vertebral body fractures of L2, L3, L4
Dental pathologies	periapical lesions on urP4 and urC AMTL
Other pathologies	-

Dental status

R	x	x	x	x	/	/	/	/	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

<u>Sk314-20/ [8220]</u>

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/3
Completeness: 15%
Sex: indifferent

Age: 0–1 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	n/a
Endocranial changes	n/a
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk314-21/ [8220]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/3
Completeness: 27%
Sex: indifferent
Age: 7–12 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	-
IVD	n/a
Trauma	-
Dental pathologies	n/a
Other pathologies	-

Dental status

R	-	-	-	-	-	-	-	-	-	- L
	dm2	dm1	/	/	/	/	/	/	dm1	dm2

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- L
	-	-	M1	nE	nE	nE	nE	nE	nE	nE	nE	nE	nE	M1	nE	nE

G315

Orientation: E–W, burial chamber E

Superstructure: -
Shaft:

Dimensions: 1.50m EW x 0.50m NS, depth: 1.40m
Description:

The rectangular, E–W aligned shaft of the grave [8312] is vertically carved into the alluvial silt and underlying bed rock and features straight walls and a flat bottom. The low depth and lack of ceiling of the chamber indicates significant surface deflation. The shaft was entirely backfilled with a deposit of yellow, windblown sand [8311] containing a large amount of heavily fragmented, disarticulated human remains. In the eastern half of the shaft, several large schist stones were recovered from within the windblown sand [8313], comprising parts of the destroyed blocking structure to the eastern burial chamber [8318].

Eastern chamber

Dimensions: 2.00m EW x 2.20m NS, height: 0.80–0.90cm
Number of burials: 3
Description:

The burial chamber is of sub-circular outline, partially carved into the schist bedrock. The ceiling had partially eroded away, partially collapsed into the chamber. The content of the burial chamber was very heavily disturbed and comprises a sequence of layers of windblown sand mixed silt rubble containing highly fragmentary, eroded remains of at least two adult and one sub-adult individuals ([8317], [8320], [8322], [8324]). No articulations remained intact. Fragments of doum palm wood indicate that at least some of the individuals were buried in doum palm coffins. Aside from disarticulated wooden fragments, no finds or ceramics were recovered associated with the individuals.

G317

Orientation: E–W, burial chamber: E

Superstructure: -
Shaft:

Dimensions: 0.85m EW x 0.50m NS, height: 0.90m
Description:
Entrance to the burial chamber was provided by a small, oval shaped shaft carved vertically into the alluvial silt [8351]. The shaft was backfilled with yellow windblown sand [8353] with a small number of scattered human remains. No remnants of a door blocking structure were recovered.

Finds

[8353]	F8352	small circular cornelian bead, (t: 0.3cm, d: 0.5cm)

Eastern chamber:

Dimensions: d: 1.95m, height: 0.80m
Description:
The burial chamber is sub-circular, cut into the alluvial silt with straight walls and an even floor. The ceiling had been eroded away, leaving the chamber open. It was backfilled with yellow, clean windblown sand entering from the surface [8352] which contained some disarticulated human bones and wooden fragments. In a depth of 0.80m below surface, there is another deposit consisting largely of windblown sand [8354] filling the entire chamber. Amongst a number of scattered human bones, it also containing partially articulated torso elements, belonging to adult individual Sk317-2/ [8355] underneath. Along the side walls of the chamber, there are disturbed remains of three more individuals [8356], [8358] including the partially articulated remains of an infant Sk317-3 and articulated legs of an adult in the south-western corner.

Ceramics

[8355]	C8080, C8081	plate with red-painted rim
[8358]	C8082	plate with red-painted rim
	C8083	small ovoid jar

Finds

[8352]	F8351	white bi-conical ivory bead (0.6x0.5cm), a blue circular faience bead (d: 0.6cm) an rectangular ivory spacer bead (l: 1.6cm, w: 0.6cm, t: 0.4cm)
[8354]	F8353	two small bi-conical beads in cornelian (d: 0.5cm)
[8356]	F8357	poorly preserved cowry shell (l: 1.0cm, w: 0.9cm, t: 0.7cm)
	F8358	three beads: circular blue faience (d. 0.5cm) , tubular brown faience (l: 1.2cm, d: 0.5cm) and bi-conical bone (0.7x0.5cm)
[8358]	F8359	group of beads: six small spherical blue faience beads (d: 0.6cm), two biconical bone beads (0.7x0.5cm), three sub-spherical cornelian beads (0.5x.0.3cm), one tubular faience bead

	(1.3x1.5cm), one circular faience bead (0.6x0.2cm) on nerita shell (1.1x0.9cm)
F8360	pumice stone (l: 8.5cm, w: 7.5cm, t: 5.0cm)

Burials

Sk317-1/ [8355]

Funerary ritual
Body Orientation: -
Body Position: -
Associated finds: -

Skeleton
Articulation: disarticulated
Bone preservation: 5/2
Completeness: 27%
Sex: female
Age: 21–35 years
Stature: -
Pathologies:

Orbital lesions	n/a
NBF	mixed lesions on right proximal femur involving trochanter major and right iliac blade active on left distal tibia
Sinusitis	n/a
Ribs	-
Endocranial changes	remodelled NBF in the *sulcus sinus sagittalis* and on right parietal bone
OA	-
IVD	n/a
Trauma	2nd and 3rd metacarpal
Dental pathologies	n/a
Other pathologies	-

Dental status: no teeth

Sk317-2/ [3255]

Funerary ritual
Body Orientation: NW–SE
Body Position: extended, supine
Associated finds:

F8354	six circular green faience beads, (d: 0.4-0.7cm)
F8355	doum palm coffin fragments
F8356	two cowry shell beads, (l: 1.1cm, w: 0.8cm, t: 0.6cm)

Skeleton

Articulation: partially articulated

Bone preservation: 5/3

Completeness: 26%

Sex: indifferent

Age: 25–35 years

Stature: 154.5 ± 2.3cm

Pathologies:

Orbital lesions	n/a
NBF	remodelled NBF on both tibiae (medial and lateral shaft) and fibulae
Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	all sections of the spine both ACJ, elbows, both hands and feet
IVD	all sections of the spine
Trauma	vertebral body fracture Th7 healed on distal left ulna
Dental pathologies	n/a
Other pathologies	very thin and porous cortices and very light and brittle bones, thin spongiosa in most joint ends

Dental status: no teeth

Sk317-3

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 5/2

Completeness: -

Sex: indifferent

Age: 20–25 years

Stature: 162.2 ± 4.1cm

Pathologies:

Orbital lesions	n/a
NBF	remodelled focus on left iliac blade dorsal, left os pubis, left auricular surface

Sinusitis	n/a
Ribs	-
Endocranial changes	n/a
OA	thoracic spine
IVD	-
Trauma	-
Dental pathologies	AMTL
Other pathologies	Schmorl's nodes in lower thoracic and lumbar spine

Dental status

R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
	x	x	/	/	/	/	/	/	/	/	/	/	x	x	x	x	

Sk317-4/ [8357]

Funerary ritual

Body Orientation: N–S

Body Position: extended, supine

Associated finds:

F8350 doum palm coffin

Skeleton

Articulation: articulated

Bone preservation: 5/3

Completeness: 79%

Sex: male?

Age: 36–50 years

Stature: -

Pathologies:

Orbital lesions	n/a
NBF	mixed NBF along entire shaft of both tibiae (medial and lateral) and fibulae
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	right shoulder, both elbows, wrists, hands, left knee, both feet
IVD	n/a
Trauma	small healed depression fracture on right parietal healed fractures of the right distal ulna and radius healed fracture of 1st right metatarsal
Dental	-

pathologies	
Other pathologies	RCD

Dental status: no teeth

Sk317-5

Funerary ritual

Body Orientation: -

Body Position: -

Associated finds: -

Skeleton

Articulation: disarticulated

Bone preservation: 4/3

Completeness: 24%

Sex: indifferent

Age: 3–4 years

Stature: -

Pathologies:

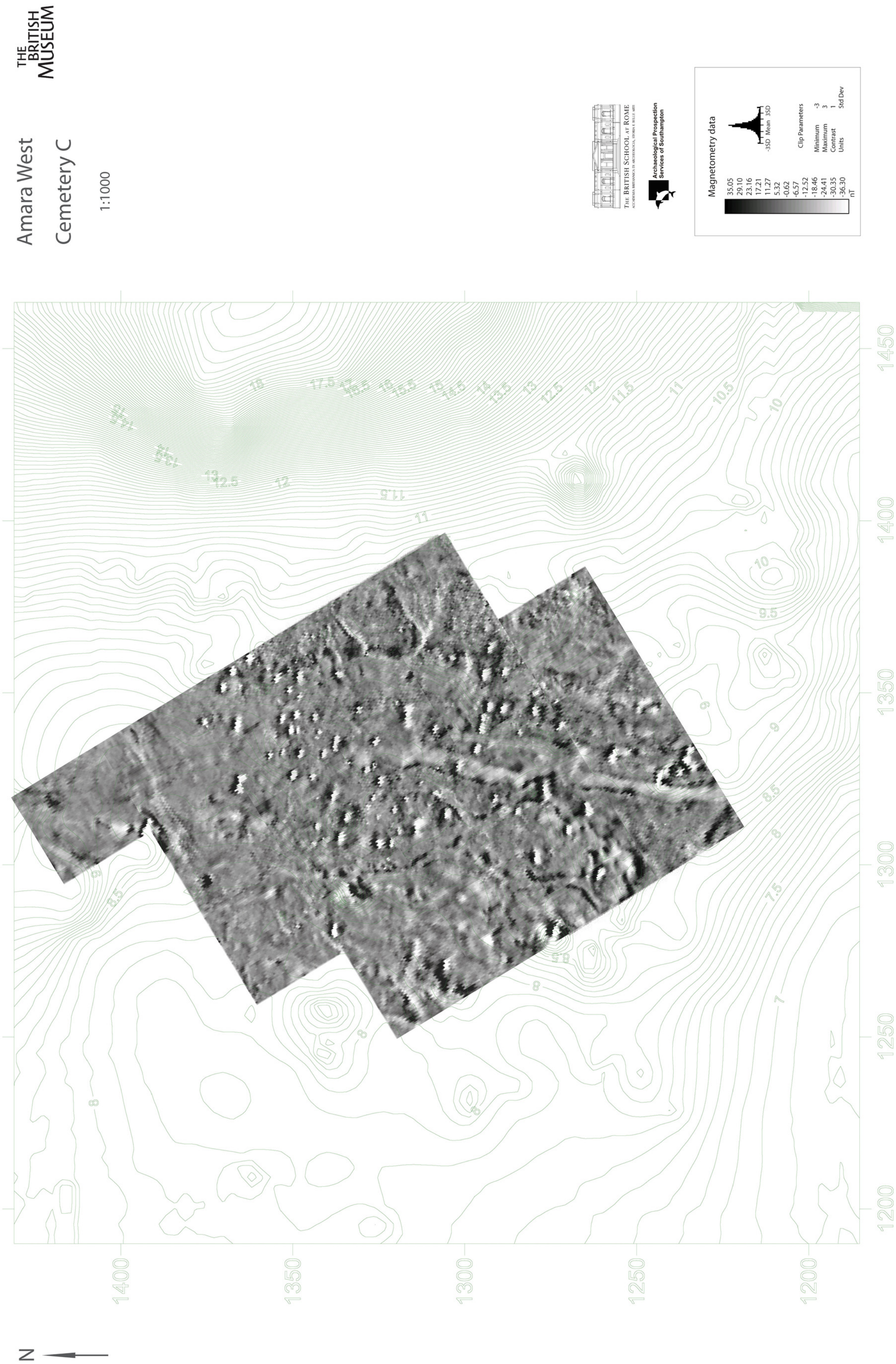
Orbital lesions	n/a
NBF	-
Sinusitis	n/a
Ribs	-
Endocranial changes	-
OA	-
IVD	n/a
Trauma	-
Dental pathologies	-
Other pathologies	-

Deciduous dentition

R	-	dm1	-	-	-	-	-	-	-	-	L
	-	-	-	-	-	-	-	-	-	-	

Permanent dentition

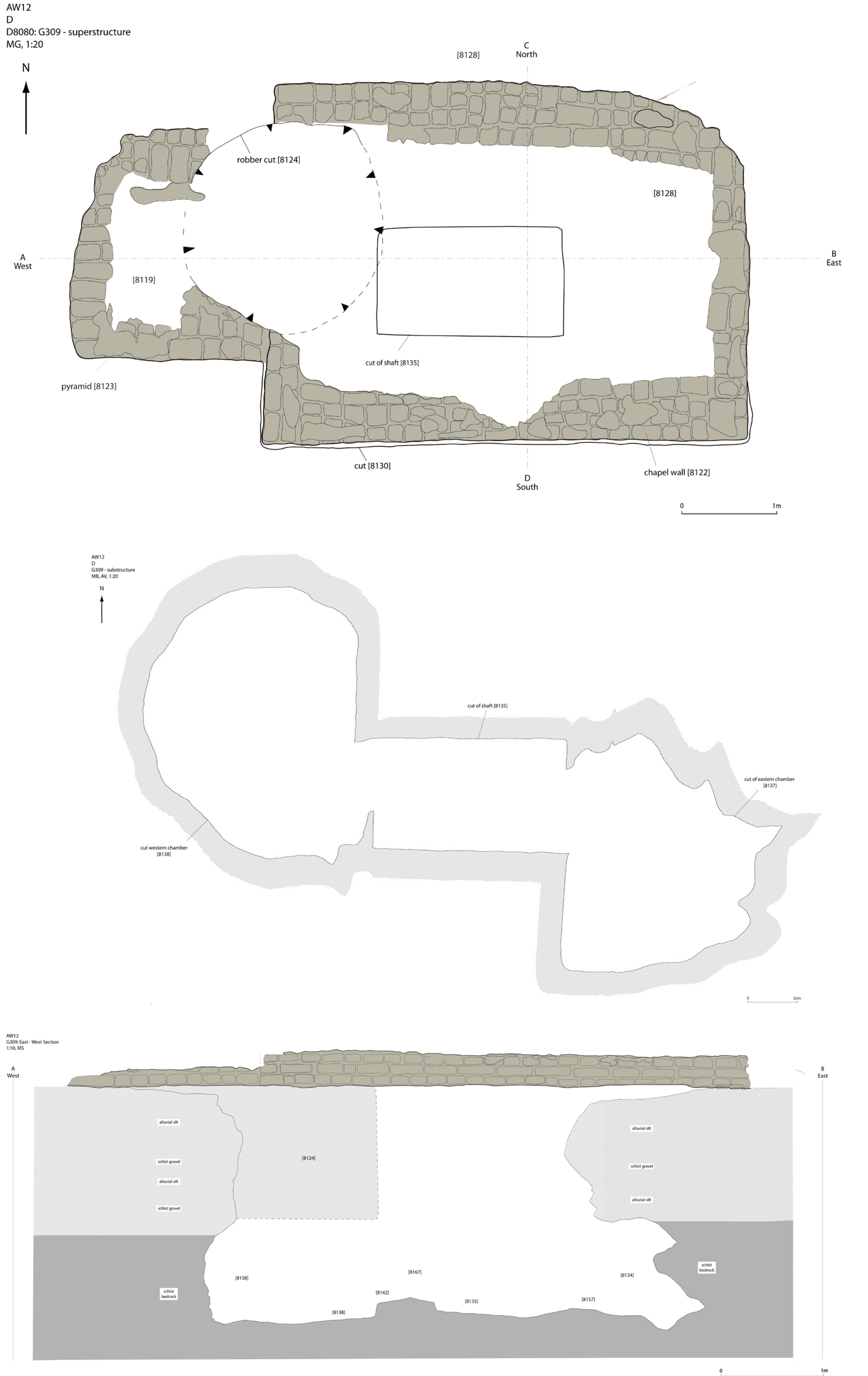
R	-	-	-	-	-	-	-	-	-	-	-	-	-	M1	-	-	L
	-	-	/	nE	nE	nE	/	I1	I1	I2	nE	-	-	-	-	-	



III.1. Magnetometry map of Cemetery C

III.2. Magnetometry map of Cemetery D

Pyramid tombs



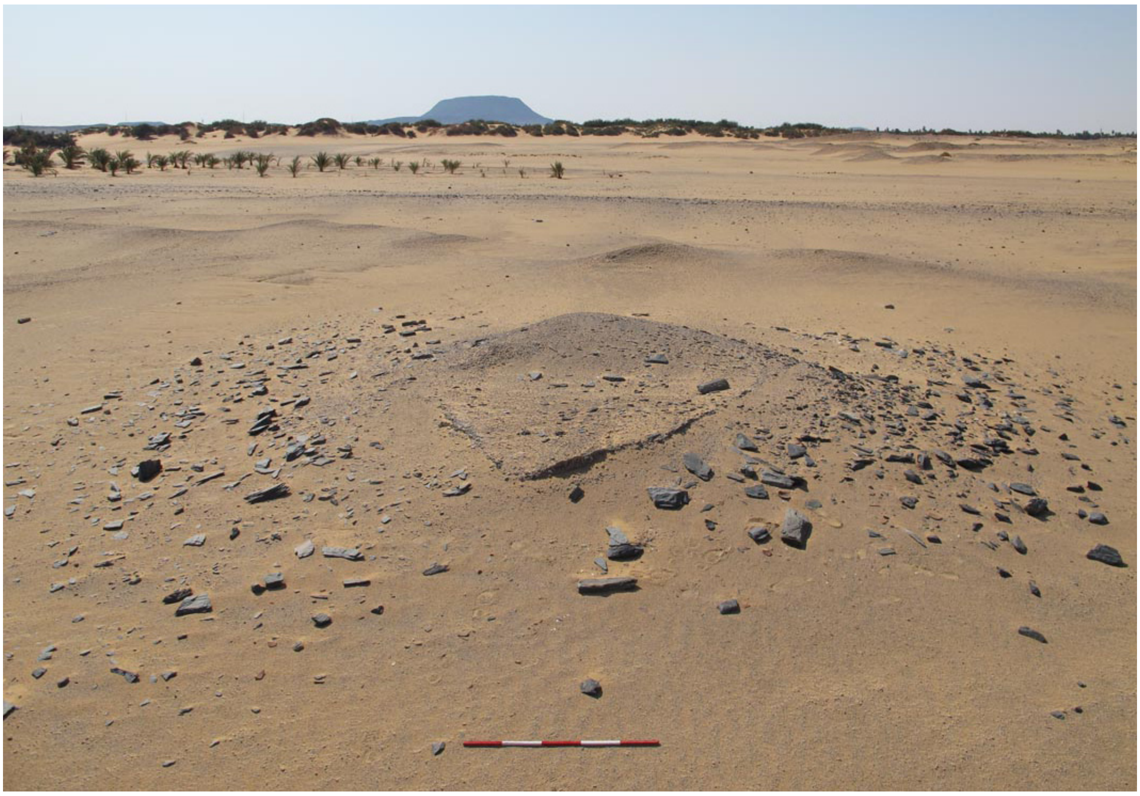
III.3. G309: superstructure (top), substructure (middle) and section (bottom)

Pyramid tombs

III.4 Superstructure of G301 - view east

III.5 Superstructure of G112 with caping stone in situ - view south-west

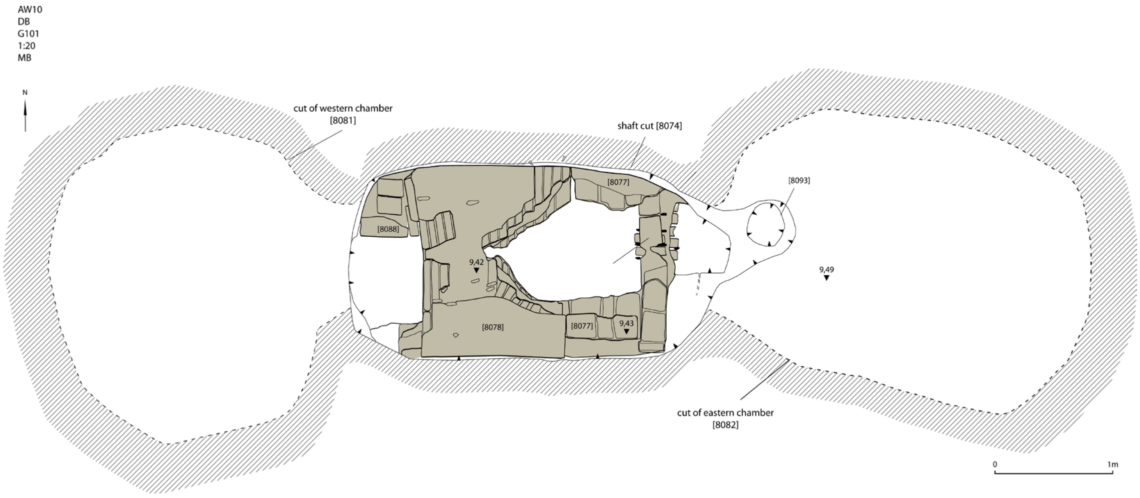
Chamber tomb with tumulus superstructure



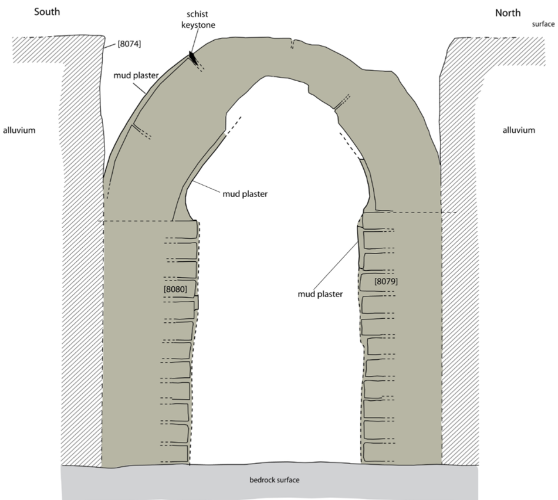
III.6 Superstructure of G244, view south

III.7 3D Reconstruction of Substructure of G244, view from north-west (created by S. Green)

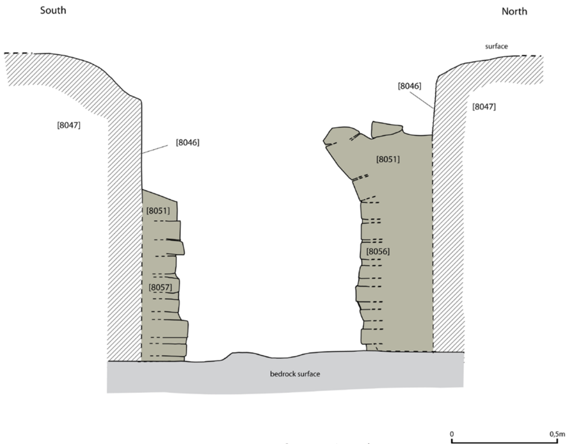
Vault tombs



III.8 Plan of G101



III.9 G101: NS-section of vaulted structure

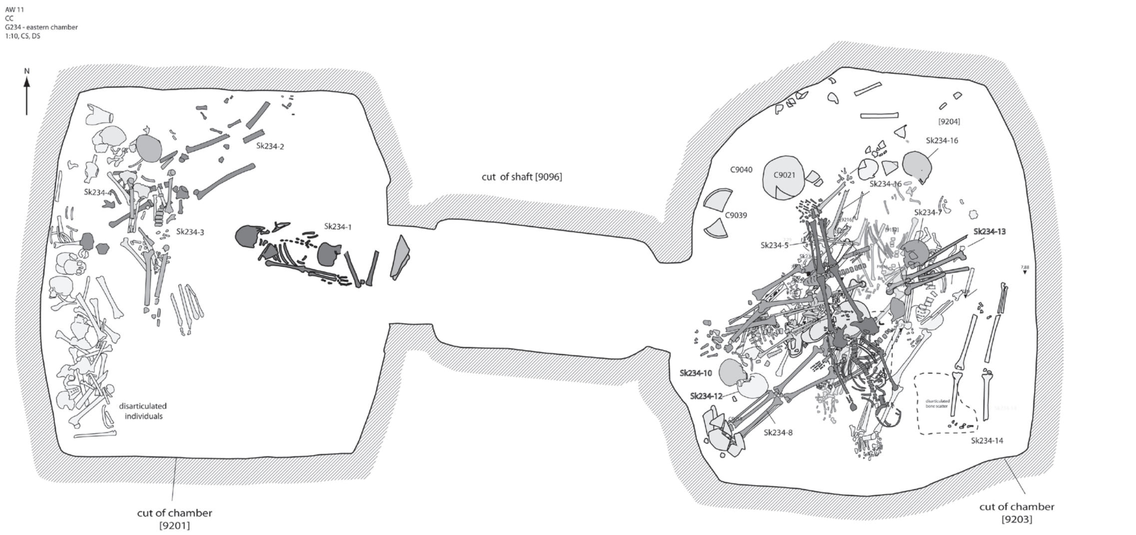


III.10 G305: NS-section of vaulted structure

III.11 G101: Vaulted structure in shaft from above (view north)

III.12 G305: Vaulted structure in shaft from above (view west)

Simple chamber tombs



III.13 Simple chamber tomb G234: Plan (top) and E-W section (bottom)

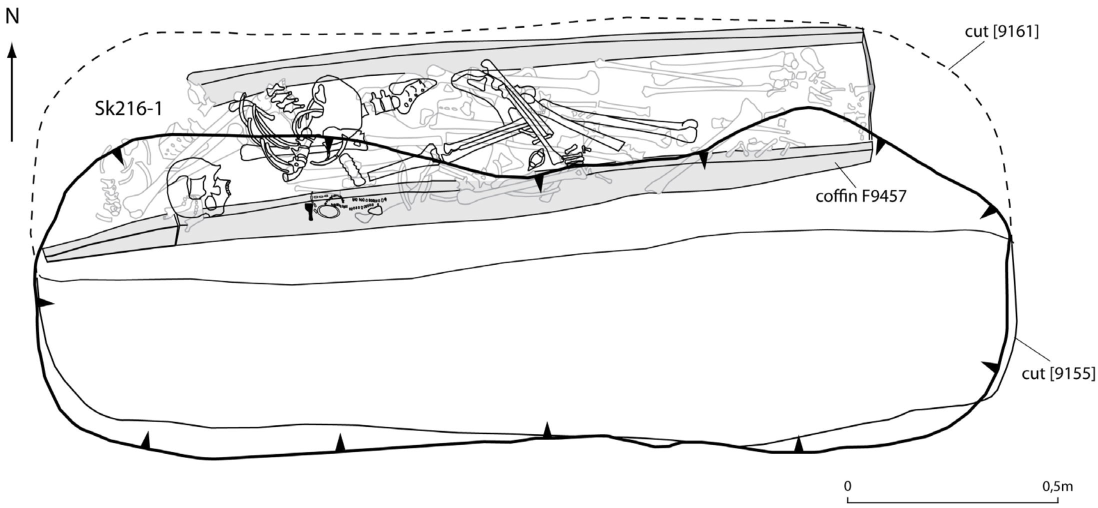
Door blocking structures

III.14 G301: Mud brick wall blocking entrance to of western chamber

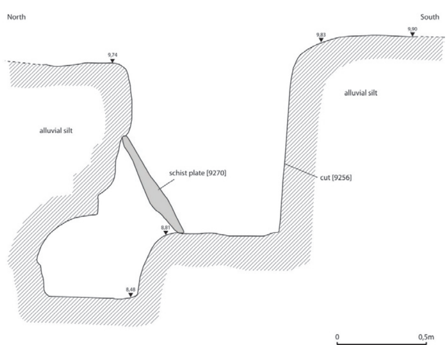
III.15 G309: Destroyed blocking structure of western chamber with schist stone door lintel

III.16 G309: Blocking structure of schist stones and mud plaster

Niche burials



III.17 Niche burial in plan (G216, post-New Kingdom)



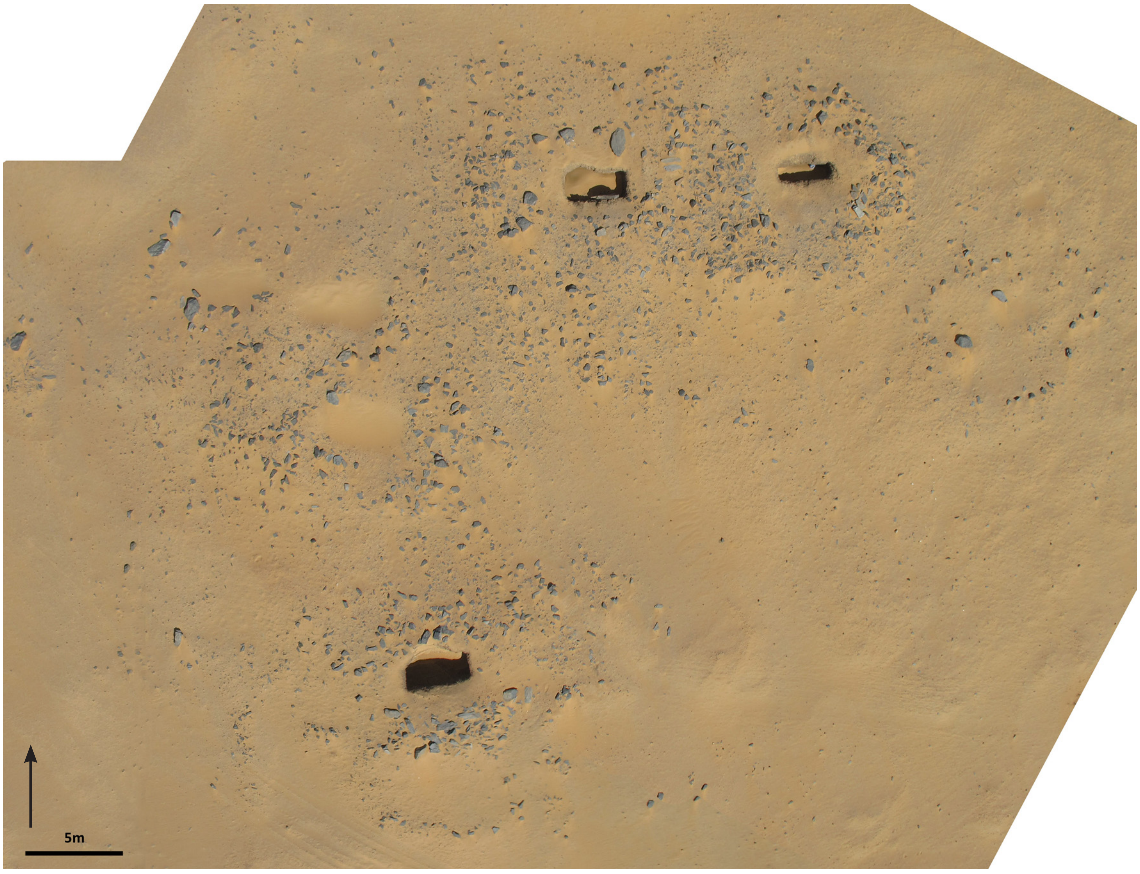
III.18 Niche burial in section (G240, post-New Kingdom)

III.19 Niche burial G237 with northern niche (view north)

III.20 Partially intact blocking structure of G237 (view north)

III.21 Inscribed door lintel blocking the niche in G210 (view south-west)

Niche burials with tumulus superstructures



III.22 Tumulus superstructures of niche burials G238-G246 in Cemetery C (Kite photograph, S. Green, photomosaic created by M. Binder)

Assemblages of grave goods

New Kingdom period

Cemetery C

G234 – eastern chamber

III.23 Faience beads F9172, carnelian ear-rings F9161 (top), F9163 (bottom), scarabs F9169 (top, both views), F9164 (left bottom), F9169 (right

III.24 Ceramics assemblage: Beer jars (left to right) C9021, C9019, C9020, C9041, plates (top to bottom): C9038, C9039, C9042

G244 - 244.3 (season 2013)

III.25 Ceramics assemblage (left to right): C9075, beer jar C9162, marl clay jar C9072, vase C9073, funnel necked jars C9070 and C9071

III.26 Coffin fragments (cw from top left): F9669, F9712, F9707

III.27 Scarabs F9684 (top), F9290 (bottom), scaraboid F9273 (both views), plaque F9291 (both views)

III.28 Faience vessel F9717 (views from all sides)

Cemetery D

G301 – western chamber

III.29 (top) Pottery assemblage marl clay amphora C8009, beer jar C8008, C8006, C8007, C8005, C8004, plate C8003

III.30 (central) Scarab F8023

III.31 (far right) Shabti F8004

G309 – western chamber

III.32 Grave goods associated with Sk309-7: mirror F8448, ear-rings F8443, F8444

III.33 Coffin mask associated with Sk309-7: left: in-situ, right: reconstruction (Illustration: E. Greifenstein, C. Thorne)

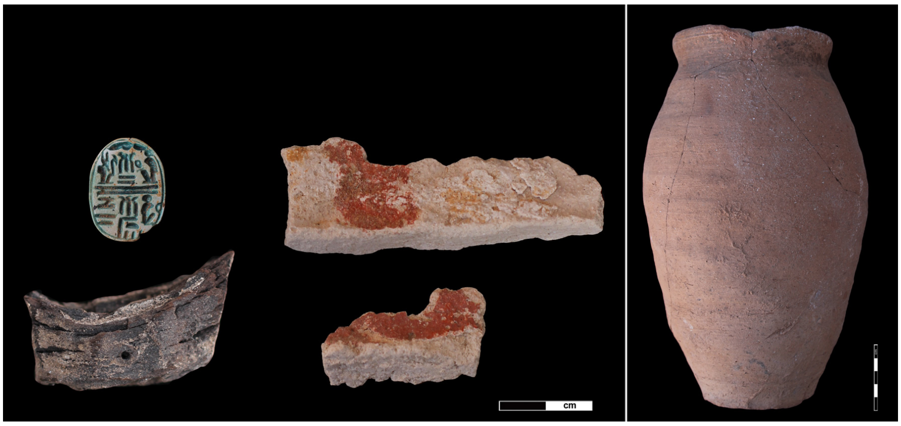
III.34 Panel from left side of coffin of Sk309-7 (F8110)

III.35 Decoration on right side of coffin of Sk309-7 (F8110)

G309 – western chamber (cont.)

III.36 Ceramic assemblage (clockwise from top left) C8025, C8024, C8027, C8028, C8026

G319 – western chamber

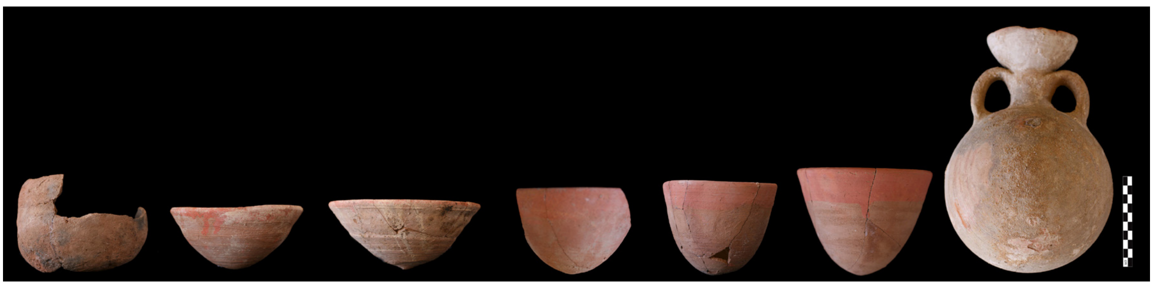


III.37 Assemblage of grave goods: Scarab F8365, headrest F8367, painted plaster fragments F8366, beer jar C8083

Post-New Kingdom

Cemetery C

G201 – eastern chamber



III.38 Assemblage of vessels (left to right): C9100 (handmade bowl), C9005, C9006, C9004, C9002, C9003, pilgrim flask C9000

G201 – eastern chamber

III.39 Copper alloy bowl F9044

III.40 Plates: C9121, C9123, C9122 (top to bottom), bowls: C9116, C9112, C9124 (left row), C9119, C9013, C9120, marl clay jar C9016, C9014, C9129)

III.41 Small finds from the chamber: Scarabs (left to right): F9039, F9055, F9024, F9027; Isis amulet F9041; Bes amulet F9058. Corn flower beads: F9047 (left), F9042 (right); penannular earrings (left to right): F9037, F9038, F9056; toiletry articles (left to right): kohl pot F9020, kohl applicator F9023, pigment container F9022; unknown organic object F9036. Shells F9036, F9040, F9054

III.42 (left) Plaster fragments from coffins: top F9079, middle F9030, bottom F9000

III.44 Wooden headrests: F9064 (top), F9666 (bottom)

III.45 Carved elements of funerary beds (cw from left top: F9078, F9075, F9077)

G201 – western chamber

III.46 Scarabs: top row: F9497, F9499, F9024, bottom row: F9055, F9490

III.47 Plates: C9011, C9117, C9008, C9118 (top to bottom), jars C9010, C9113, C9009, C9128

G243 – western chamber

III.48 Scarabs F9198, F9203, metal ring F9202, tweezers F9206

III.49 Ceramic assemblage: beer jars C9050, C9051, C9054, miniature bottle C9055, plates C9053, C9057

G211 – western chamber

III.50 (top left) Basketry fragments F9686, inscribed plaque F9100, ivory plaques F9061, Hathor head amulets F9063 & F9060, tweezers F9053, beads F9062, faience situla F9049

III.51 (bottom left) Fragments of funerary beds: bed terminal F9729, stringing on side plank F9048, smaller elements F9074

III.52 (top right) Pilgrim flask C9007

Cemetery D

G301 – north-eastern chamber

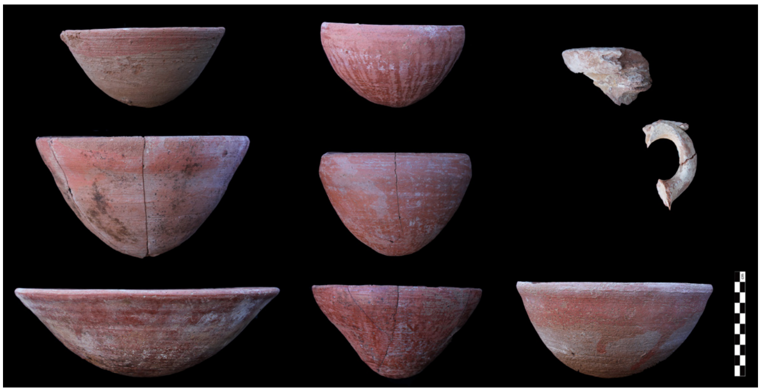
III.53 Group of amulets F8010, penannular ear-rings and group of beads F8050

G309 – eastern chamber

III.54 Ceramic assemblage (left to right): pilgrim flask C8019, bowls C8022, C8021, hand made bowl C8014

G314

III.55 Finds from the eastern chamber (selection): Funerary bed element F8207, basket fragment F8203, beads F8201, scarab F8205



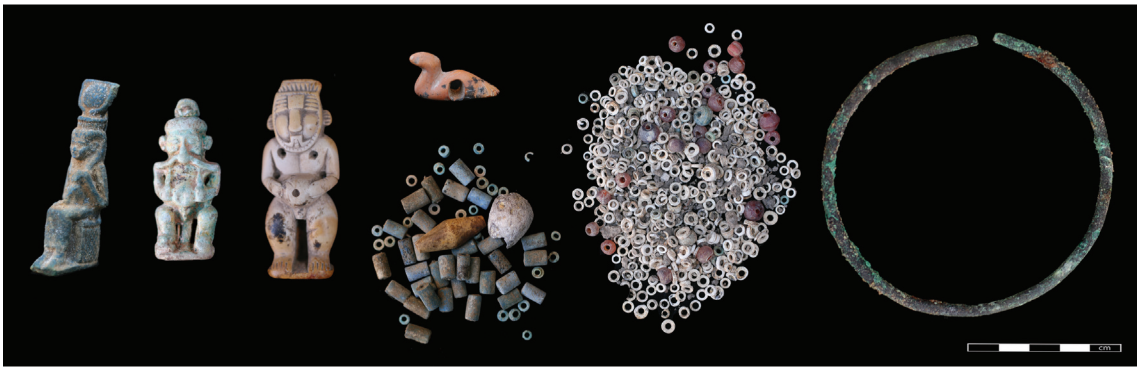
III.56 Ceramics assemblage from the eastern chamber: left column: C8202, C8055, C8050, middle column: C8048, C8049, C8204, right column: pilgrim flask C8046, C8205

III.57 Ceramics assemblage from the western chamber: bowl C8053, jar C8052

Niche burials

III.58 G204 Bowl of Nubian tradition C9012

III.59 G210 Faience and ostrich egg shell beads F9011, bracelet fragment F9014



III.60 (top) Small finds from G216 (left to right): Isis amulet F9466, Pataikos amulet F9467, Bes amulet F9453, duck amulet F9479, necklace F9465, necklace F9464, bracelet F9463

III.61 (left) G216 ceramics assemblage (clockwise from top left): C9140, C9141, C9143, C9144

III.62 G226: Two baskets placed near the feet of Sk226-1 in a post-New Kingdom niche burial

III.63 Ceramic assemblage of G226: Pilgrim flask C9017, marl clay jar C9018

III.64 G233 (left to right): Calcite beads F9153, bone needle F9150, red-burnished bowl C9139

III.65 (left to right) G238: Plaster fragments F9535, tail bones F9500, ivory fragments F9503

III.66 (left) G239: Copper alloy needles F9509, F9507, copper alloy hook F9511, cowry shell beads F9510

III.67 (far left) G239: Ceramic assemblage bowl with red rim C9044, red burnished bowl C9150, pilgrim flask C9153

III.68 Small finds (left side) ivory objects F9158, ivory bead fragment F9529, carved wooden element F9519, mud gaming piece (?) F9529, pebble (gaming piece?) F9527

III.69 Bread moulds (right side, left to right) C9045, C9046, C9047

Dental disease

III.70 Large carious lesions affecting all upper molars of young adult male Sk243-15

III.71 Periapical lesions on M^2 and M^3 of Sk243-15

III.72 Periapical lesions in the maxilla of middle adult male Sk244-6

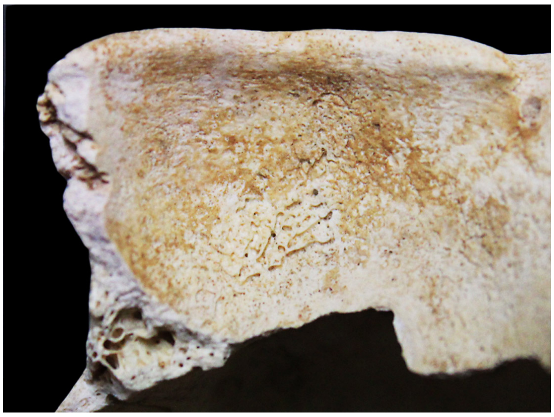
III.73 Ante-mortem tooth loss in a middle adult male (Sk305-2)

III.74 Ante-mortem tooth loss in a middle adult male (Sk201-1)

III.75 Dental attrition in a middle adult female (Sk243-12)

Orbital lesions

III.76 Vessel impressions in the orbit of middle adult male Sk211-7 (post-New Kingdom)



III.77 Slight hypertrophy and vessel impressions in the orbit of young adult male Sk218 (post-New Kingdom)

III.78 Porosity and hypertrophy in the orbit of 6-7 year old sub-adult Sk226-4 (post-New Kingdom)

III.79 Porosity in the orbit of young adult male Sk244-3 (New Kingdom)

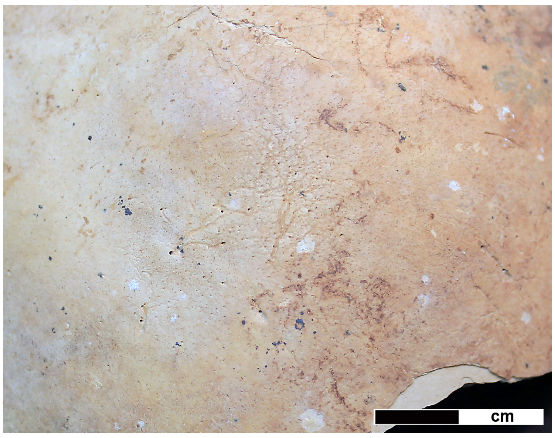
III.80 Vessel impressions and hypertrophy in the orbit of post-New Kingdom adult female Sk300-1

III.81 Circular lesion in the orbit of middle adult female Sk314-9 (post-New Kingdom)

Scurvy

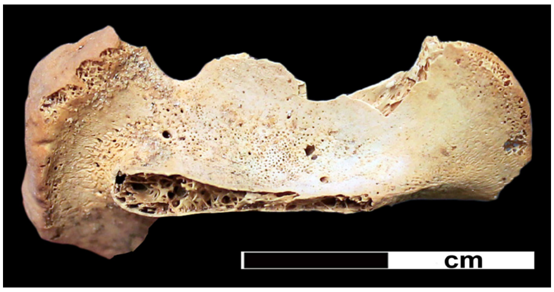
III.82 Porous lesions in 3-4 year old sub-adult Sk210-3 (post-NK; from top left clockwise: orbital roof, orbital floor, greater sphenoid wings, maxilla)

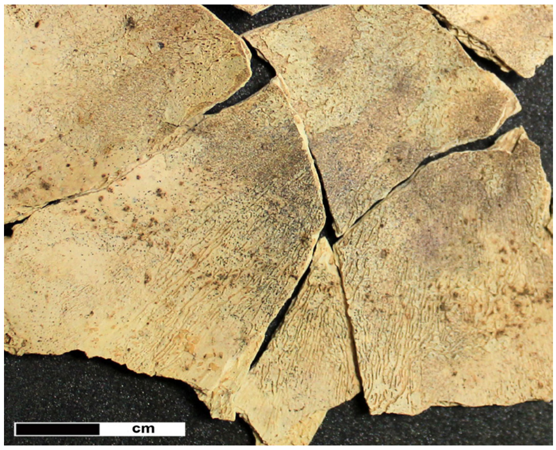
III.83 Stellate vessel impressions on parietal bone of Sk210-3



III.84 Stellate vessel impressions on parietal bone of post-NK sub-adult (5-7 years) Sk210-4

III.85 New bone formation in the right orbit of post-NK sub-adult (5-7 years) Sk210-4



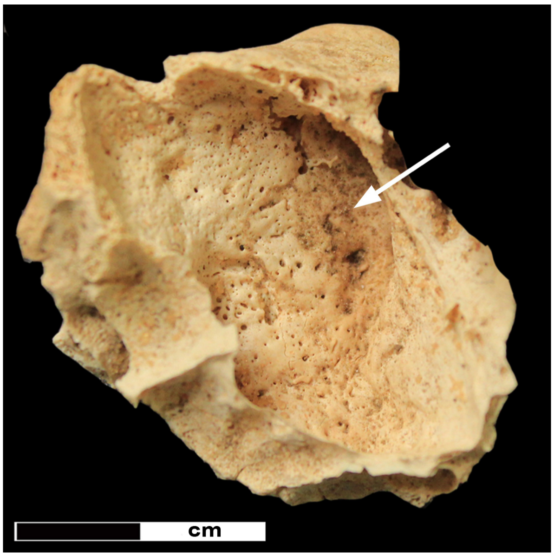


III.86-88. Lesions potentially caused by scurvy in post-New Kingdom Sk243-1: Porosities in the supra-scapular fossa (top left), new bone formation in the frontal bone (left) and parietal bone (top)

Infectious disease

III.89 New bone formation on the lateral side of the left tibia of middle adult female post-New Kingdom individual Sk305-1

III.90 New bone deposition on the latera side of the right tibia of a middle adult male Sk211-7 (post-New Kingdom)

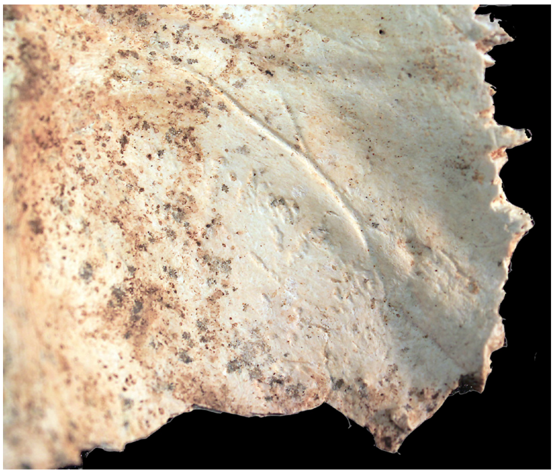


III.91 Remodelled NBF in the maxillary sinus of middle adult male individual Sk244-6 (New Kingdom)

III.92 Active new bone formation on the visceral side of the ribs of middle adult male individual Sk201-3 (post-New Kingdom)

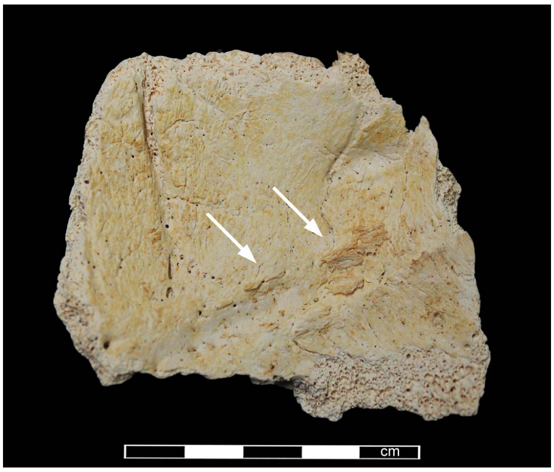
III.93 Remodelled new bone formation on the visceral side of the ribs of old adult male individual Sk238 (post-New Kingdom)

Endocranial changes



III.94 Granular impressions in Sk233-1(indifferent adult, post-New Kingdom)

III.95 Vessel impressions in the frontal bone of post-New Kingdom middle-adult male Sk305-2



III.96 Plate-like new bone formation in New Kingdom middle adult male Sk244-6

III.97 Hyperostosis frontalis interna in post-New Kingdom middle adult female Sk314-11

III.98 Surface changes in the occipital bone of Sk243-12 (20-30 years, indifferent)

Degenerative joint disease

III.99 Bilateral osteoarthritis in the radial head of Sk216-1in a young adult female (Sk216-1, post-New Kingdom)

III.100 Osteoarthritis in the right patella of a middle adult male (Sk305-1, post-New Kindom)

III.101 Bilateral osteoarthritis in the first carpo-metacarpal joint (middle adult female Sk314-7, post-New Kingdom)

III.102 Rotator cuff disease in the right humeral head (young adult female Sk305-3, post-New Kingdom) Tat, quat dignibh euisl ut adio core mod dolore d

III.103 IVD in the lower cervical and upper thoracic spine (Sk305-9, adult, post-New Kingdom)

III.104 IVD in the lower cervical and upper thoracic spine, inferior aspect of vertebrae (Sk305-9, adult, post-New Kingdom)

Gout

III.105 Cavitations in *ossa cuneiforme laterale* of middle-adult male Sk201-2 (top medial aspect, bottom proximal aspect)

III.106 Cavitations in tarsals of middle-adult male Sk201-3 (top *os cuneiforme mediale* dorsal and lateral view)

Ankylosing Spondylitis

III.107 Sacrum of old adult male Sk238 with full fusion of sacro-iliac joint (arrows)

III.108 Full fusion of the vertebral bodies in the cervical and upper thoracic spine of Sk238 (post-New Kingdom, anterior and posterior view)

DISH

III.109 (above). Osteophytes in lower thoracic vertebrae of adult male individual Sk305-9 (post-New Kingdom possibly indicating DISH

III.110 (left) Vertebral column of middle adult male individual Sk301-4 (New Kingdom)

Osteoporosis

III.111 Vertebral body of female middle adult individual Sk234-2 (post-New Kingdom)

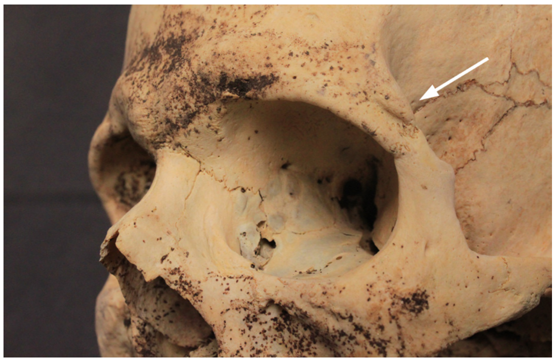
Trauma

Cranial trauma

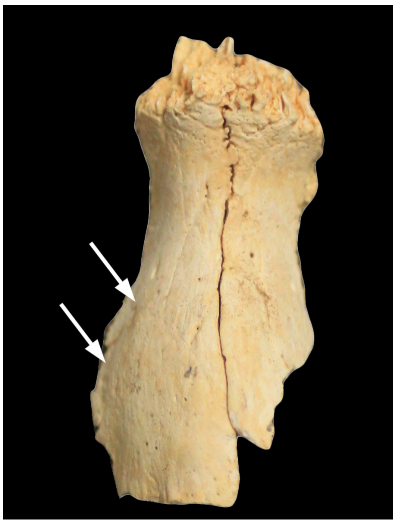
III.112 Small depression fracture on frontal bone (Sk201-5)

III.113 Healed sharp force trauma on the frontal bone (Sk201-5)

III.114 Depression fracture on the frontal bone of Sk243-3



III.115 Fracture of the left orbital rim (Sk201-1)



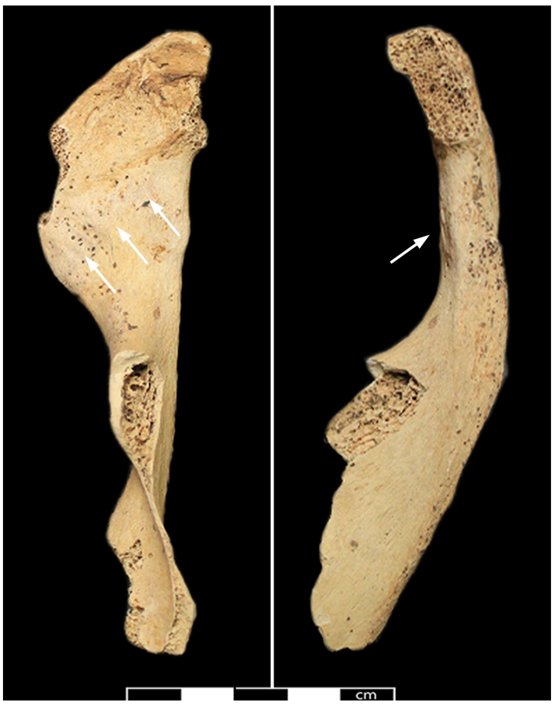
III.116 Fracture of the nasal bone of Sk201-5

Clavicles

III.117 Fracture of the medial shaft of right clavicle (Sk244-10)

III.118 Healed fracture on the medial shaft of the right clavicle (Sk243-6)

III.119 Double fracture of the right scapula (arrows), left: dorsal view, right: superior view (Sk305-9, adult male, post-New Kingdom)

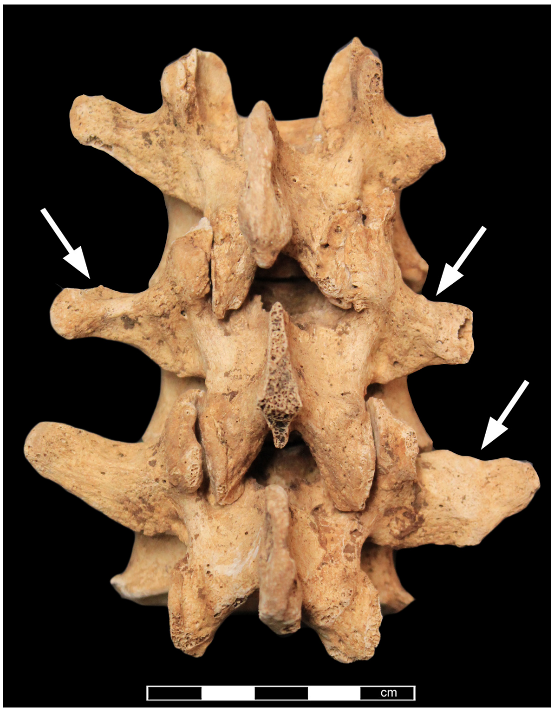


III.120 Healing fracture of the sternum of Sk237 (post-New Kingdom, middle adult female (above)

III.121 Oblique fracture of the acromion of Sk211-7 (left, post-New Kingdom, middle adult male)

Trauma

Spinal fractures - Neural arch



III.122 Fractures of the lateral processes of L2 and L3 of middle adult male Sk211-2 (post-New Kingdom)

III.123 Fracture of the neural arch of C1 in a post-New Kingdom young adult female Sk314-16

III.124 Fracture of spinous process of Sk211-7 (post-New Kingdom, middle-adult male)

Spinal fractures - Vertebral body

III.125 Crush fracture of the vertebral body, lateral view (middle adult female Sk226-7, post-New Kingdom)

III.126 Avulsion fracture of the vertebral rim with fracture elements in front (Sk243-4, middle adult male, post-New Kingdom

III.127 Vertebral body fracture, (middle adult female Sk226-6, post-NK)

III.128 Vertebral body fractures in young adult female Sk216-3 (post-New Kingdom

Trauma

III.129 Fractures of the left humerus, right radius and ulna in a post-New Kingdom middle adult male (Sk211-7)

III.130 Fracture of the right humerus (middle adult female, Sk237, left)

III.131 Fractures to the distal radius and ulna (middle adult female Sk226-7)

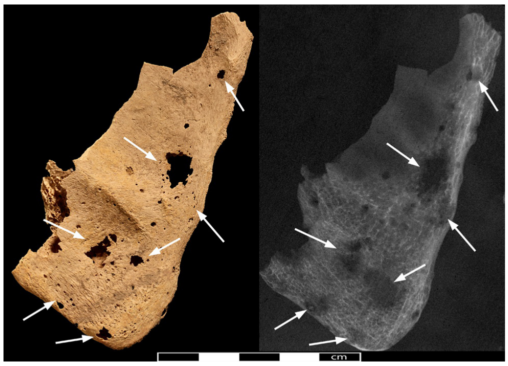
III.132 Fracture of the left iliac blade of middle adult female Sk237 (post-New Kingdom)

III.133. Triple fracture of the right pelvis in a young adult male in G234 (New Kingdom)

III.134 Fracture of the right proximal shaft of the femur

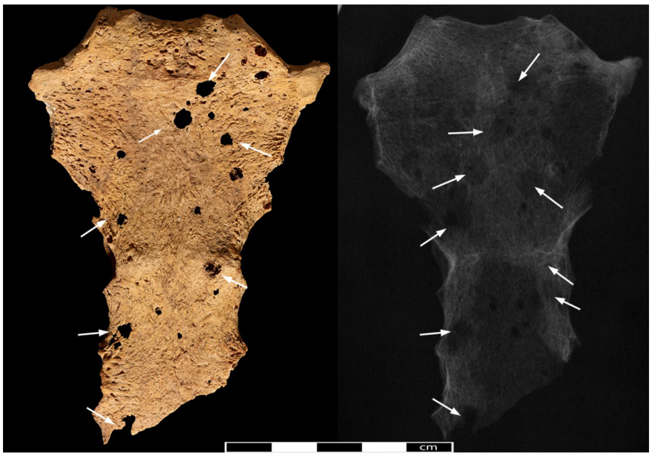
Metastatic cancer (Sk244-8)

III.135 Lytic lesions in the left clavicle

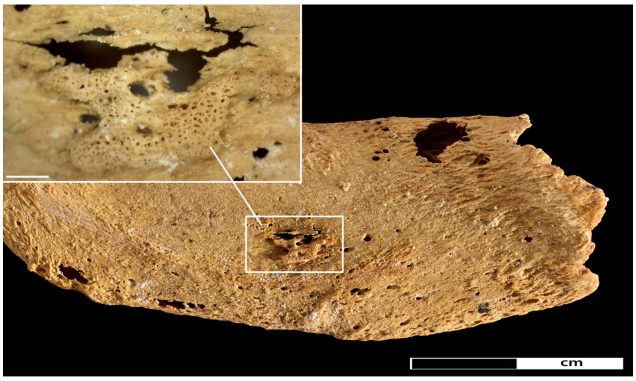


III.136 Lytic lesions in the right scapula

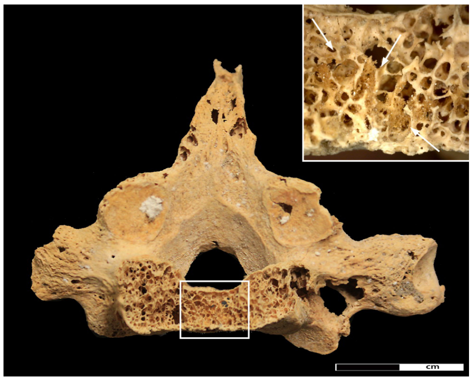
III.137 Left first rib (detail see Plate 27.5)



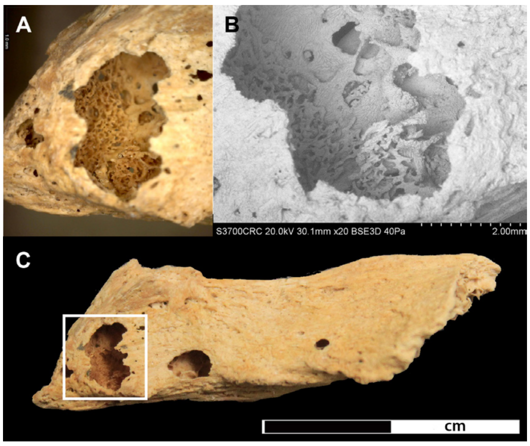
III.138 Lytic lesions in the sternum



III.139 New bone formation associated with lytic lesion in first rib



III.140 Lytic lesion with new bone formation in a thoracic vertebrae

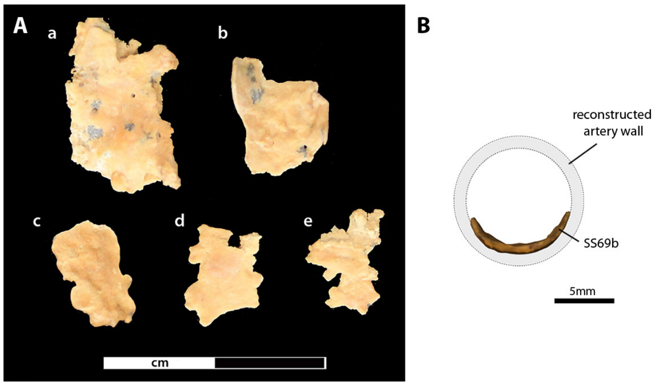


III.141 Lesion with bone formation in a spinous process (C), close-up (A) and SEM image (B) of the lesion

III.142 Close-up of new bone formation in a lytic focus in the iliac blade (30x magnification)

Calcified arterial plaques

III.143 Calcified structures along the cervical spine of middle adult male Sk244-6 (New Kingdom)



III.144 Calcified structures associated with Sk244-6 (A photograph, B 3D reconstruction, Drawing M. Binder)

III.145 Calcified structures along the cervical spine of middle adult male Sk243-3 (post-New Kingdom)

III.146 Close-up of calcified structure associated with Sk243-3

III.147 Calcified structures along the cervical spine of middle adult female Sk237 (post-New Kingdom)

III.148 Close-up of calcified structure associated with Sk237

III.149 (left) and III.150 (right). Calcified structures along the femur of middle adult male Sk305-4 (post-New Kingdom), right in close-up (© J. Veitch),

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